# WATERSHED WORK PLAN

# BRILLION WATERSHED

## CALUMET AND MANITOWOC COUNTIES, WISCONSIN





U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Prepared under the authority of the Watershed Protection & Flood Prevention Act
(Public Law 566, 83d. Congress, 68 Stat. 666) as amended.

JANUARY 1975

# BRILLION WATERSHED

Calumet and Manitowoc Counties

Wisconsin



## WATERSHED WORK PLAN ADDENDUM

U.S. Department of Agriculture

Soil Conservation Service

Prepared in Fulfillment of the Interim Requirements for Principles and Standards for Planning Water and Related Land Resources Established Pursuant to Sec. 103 of the Water Resources Planning Act (Public Law 89-80)

January 1975

## Introduction

This addendum is based on the Principles and Standards for Planning Water and Related Land Resources as developed by the Water Resources Council.

The Brillion watershed work plan is based on 1973 prices and a 5 5/8 percent interest rate. The addendum has been prepared to show the effects of a 5 7/8 percent interest rate, current (1974) installation costs, and current normalized prices.

The alternative selected for implementation, as contained in the work plan, is based on a careful and deliberate consideration of the environmental and economic impacts of the project. No known unresolved environmental issues exist. The draft environmental impact statement has been modified in response to comments.

Effects resulting from evaluation of the selected work plan are displayed under separate accounts for national economic development, regional development, environmental quality, and social well-being.

The watershed work plan addendum for phase-in of principles and standards is composed of three sections.

I. The effects of a 5 7/8 percent interest rate, current installation costs, and current normalized prices.

II. An abbreviated environmental quality plan consistent with the principles and standards to show environmental quality problems, component needs, plan elements, effects, and institutional arrangements.

III. A display of the four accounts-national economic development, regional development, social well-being, and environmental quality-which show the impacts of the selected plan.

SECTION I

## BENEFIT-COST RELATIONSHIP

Annual project costs, benefits, and benefit-cost ratio, based on a 5 7/8 percent interest rate, 1974 installation costs, and current normalized prices, are as follows:

1. Project costs are $20,654.

2. Project benefits are $52,120.

3. The project benefit-cost ratio is 2.5 to 1.0.

SECTION II

# ABBREVIATED ENVIRONMENTAL QUALITY PLAN

## ENVIRONMENTAL QUALITY OBJECTIVE

The environmental quality objective of Brillion watershed is to manage, conserve, preserve, create, restore, and enhance the quality of the environment.

## ENVIRONMENTAL PROBLEMS

### Land and Water Quality

Upland sheet erosion in the watershed is the most serious form of erosion in terms of tons of soil loss. Some cropland is currently contributing up to 13 tons per acre per year. The watershed average for cropland is about 3.1 tons per acre per year. This amounts to 2.4 inches of soil loss in 100 years. Poor drainage and flooding of the productive soils in the flood plains have pushed intensive cultivation up the slopes causing increased sheet erosion.

Other types of erosion found in the watershed are gully, streambank, roadside, and construction area erosion. Gully erosion is limited to a few small gullies in the uplands. Streambank erosion is found mainly along the main channels. Occasional raw banks with an average height of 4 feet occur. Roadside erosion is not considered a severe problem. It occurs mostly on town roads. Construction areas, though small in size, often are severely eroded. Erosion may be as much as 100 tons per acre per year on these areas.

Bank slumps and slides occur along drainageways and manmade outlet channels. These slumps and slides plug drainageways and increase the need for maintenance and cleanout. Bank slumps and slides, along with sediment deposition in drainageways and manmade outlet channels, are a major problem.

Sediment laden floodwater is the principal source of sediment damages. The major soils of the watershed are silts and clays that are carried in suspension by floodwaters. Sheet erosion from cropland is the principal contributor of sediment. Gully, streambank, and roadside erosion are other sources. Excess runoff transports these sediments from the uplands to downstream areas of deposition. Generally, the area of sediment damage is the same area damaged by floodwaters.

In urban areas sediment is deposited inside homes and commercial and public buildings. Sediment is also deposited on lawns, gardens, and driveways. Sediment deposited on parks, roads, and other public properties is esthetically undesirable.

The major sediment deposition areas are the Brillion Marsh and the drainageways adjacent to the marsh. Swamping caused by sediment deposited in these areas retards drainage and modifies wildlife wetland habitat. Long Lake has a sediment problem from continued construction in its watershed.

The predicted annual delivery of sediment to the Spring Creek bridge below Brillion is 7,200 tons for present conditions. Thus, sediment by volume is the greatest pollutant in Spring Creek.

Septic tank effluent poses a water quality problem for Long Lake. The lake has been treated to reduce algae during the past 5 years. The high fecal coliform counts in Brillion could pose a health hazard.

Biological Resources

Heavy populations of rough fish are helping to degrade the Long Lake fishery and its water quality. They have been attracted to the lake because of its high fertility. Turbidity is increased by these fish.

Competition for land uses has resulted in wildlife habitat losses. The continuing development of roads, highways, and residential areas contribute to this problem.

The destruction of farm and roadside hedgerows has reduced prime habitat for a number of species. Lack of prime habitat limits the potential numbers and distribution of upland wildlife species. Additional habitat for nesting and cover is needed to increase wildlife populations.

Forest land needs pertain mostly to diversion of productivity into food and shelter for wildlife. An additional 50 acres of reforestation is needed.

## COMPONENT NEEDS

1. Preserve land and water quality by controlling erosion.

2. Improve water quality by better management of the various land uses.

3. Preserve wetlands.

4. Control the rough fish in Long Lake.

5. Protect the flood plain and stream habitat.

6. Establish and manage wildlife habitat areas.

## PLAN ELEMENTS

1. Install land treatment measures on 6,000 acres of cropland. These measures may include, but would not be limited to; conservation cropping systems, contour farming, critical area planting, diversions, grade stabilization structures, grassed waterways and outlets, minimum tillage, hayland planting, stripcropping, terraces, and tree planting. Estimated cost for land treatment measures on cropland is $120,000.

2. Improve 600 acres of grassland with better management and treatment practices such as proper grazing use, and planned grazing systems. In addition, pasture seeding is needed to improve pastures in poor condition and formerly cultivated fields. Further improvements can be attained through proper distribution of livestock grazing. Estimated total costs are $75,000.

3. Apply management and appropriate land treatment measures on 800 acres of forest land. This will principally involve the control of forest land grazing, tree planting, and various cultural practices. Marking stands for improvement is a recommended practice for achieving multiple use-sustained yield management on forest lands. Estimated cost for establishing these practices is $13,000.

4. Install 2 miles of nature trails for educational purposes in the Brillion Marsh Area. Estimated cost is $10,000.

5. Provide zoning for all flood plains in the watershed to the 100-year flood level. Estimated cost capitalized for 100 years is $50,000.

6. Provide an electrical fish barrier for Long Lake, eradicate rough fish that now occupy the lake, and operate the barrier for 100 years. Estimated cost is $150,000.

7. Purchase or otherwise obtain control of an additional 600 acres of wetlands. Manage these wetlands to provide food and cover for wildlife. Estimated cost is $200,000.

The installation cost of all seven plan elements is $618,000.

## INSTITUTIONAL ARRANGEMENTS

The Extension Service of the University of Wisconsin can handle educational and research functions. They can conduct research and provide information useful in all phases of the environmental quality plan.

Through a cooperative agreement with the Wisconsin Department of Natural Resources, Bureau of Forest Management, the Forest Service can furnish technical assistance for forest land treatment measures to be installed by landowners.

The Soil Conservation Service can furnish technical assistance for the application of land treatment measures on cropland, grassland, and other land.

The Agricultural Stabilization and Conservation Service may provide Federal cost-sharing assistance to individual landowners in applying approved conservation practices at various rates.

Farmers Home Administration as well as local banks and other lending agencies have funds available for lending at various interest rates that can be used for most plan elements.

Local landowners and operators as well as local groups and organizations can furnish labor, land, and financial assistance toward the implementation of plan elements.

Other funds may be obtained from various sources such as public law 83-566, Outdoor Recreation Assistance Program, county, and other local funds.

The Wisconsin Department of Natural Resources can furnish information and technical assistance regarding biological needs, especially in areas of fish and wildlife.

The Calumet and Manitowoc County Soil and Water Conservation Districts can furnish information, technical assistance, and financial assistance toward fulfilling plan elements.

The Wisconsin Historical Society and the State Historic Preservation Officer can furnish information regarding historic, archeological, and architectural resources.

## EFFECTS

1. Conservation land treatment will increase water intake rates of the soil thus reducing rainfall runoff, erosion of land, sediment deposition in streams, and flood damages while at the same time increasing vegetation growth.

2. Gross erosion rates will be reduced by about 15 percent.

3. Grassland and forest land management practices will enhance wildlife values and contribute substantially to beautification, esthetic appeal, and environmental quality.

4. Wetlands preservation and wildlife habitat improvement practices will increase the availability of food and cover resulting in increased wildlife populations.

5. The rough fish control in Long Lake will improve the water quality and provide a better sport fishery.

6. Flood plain zoning will reserve the flood plain for compatible uses. The stream habitat will be protected or enhanced.

7. Overall, the land and water resources in the watershed will be improved.

SECTION III

## DISPLAY ACCOUNTS

Display accounts for national economic development, regional development, environmental quality, and social well-being are shown as a measure of effects of the selected plan. The national economic development account and the regional development account measures have both beneficial and adverse effects. The environmental quality account and the social well-being account do not differentiate between beneficial and adverse effects.

The regional economic development account compares the State of Wisconsin and the rest of the Nation in their relationship between beneficial and adverse effects.

All four accounts developed for the selected plan use existing supporting data from the work plan to develop the display tables.

SELECTED PLAN

NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

Brillion Watershed, Wisconsin

| Components | Measures of Effects (Average Annual) |
|---|---|
| Beneficial Effects: | |
| A. The value to users of increased outputs of goods and services | |
| 1. Flood prevention | $47,790 |
| Total beneficial effects | 47,790 |

| Components | Measures of Effects (Average Annual) |
|---|---|
| Adverse Effects: | |
| A. The value of resources required for a plan | |
| 1. Floodwater retarding and Long Lake structures | |
| Project installation 1/ | $16,110 |
| Project administration 1/ | 2,215 |
| O&M | 1,530 |
| Total adverse effects | 19,855 |
| Net beneficial effects | 27,935 |

1/ Amortized for 100 years @ 5 5/8 percent interest.

January 1975

SELECTED PLAN

ENVIRONMENTAL QUALITY ACCOUNT

Brillion Watershed, Wisconsin

| Components | Measures of Effects |
|---|---|
| Beneficial and adverse effects: | |
| A. Areas of natural beauty | 1. Reduction of floodwater and sediment damage will provide opportunity for improvement of rural and urban property. |
| | 2. Create lake with 48 surface acres with 1.9 miles of shoreline. |
| | 3. The level of Long Lake will be stabilized. |
| | 4. Acres of land flooded by the 100-year frequency storm will be reduced from 660 to 470. |
| B. Quality considerations of water, land, and air resources | 1. Cropland sheet and gully erosion will be reduced from 3.1 to 2.8 tons per acre per year on the uplands from land treatment measures. |
| | 2. Reduce erosion on 4,626 acres of cropland, grassland, and forest land. |
| | 3. Air pollution will be increased slightly during the project construction period. |
| C. Biological resources and selected ecosystems | 1. Increase water temperature in Spring Creek below FRS No. 1 by about 2 degrees Centigrade. |
| | 2. Provide 48-acre resting area at FRS No. 2 for migratory waterfowl. |
| D. Irreversible or irretrievable commitments | 1. Conversion of 90 acres of agricultural land to dams, spillways, and sediment pools. |



January 1975

SELECTED PLAN

REGIONAL DEVELOPMENT ACCOUNT

Brillion Watershed, Wisconsin

| Components | Measures of Effects (Average Annual) | |
|---|---|---|
| | State of Wisconsin | Rest of Nation |
| Income: | | |
| Beneficial effects: | | |
| A. The value of increased output of goods and services to users residing in the region | | |
| 1. Flood prevention | $47,790 | |
| B. Secondary | | |
| 1. Indirect and induced activities associated with net returns from flood prevention | 4,330 | |
| Total beneficial effects | 52,120 | |

| Components | Measures of Effects (Average Annual) | |
|---|---|---|
| | State of Wisconsin | Rest of Nation |
| Income: | | |
| Adverse effects: | | |
| A. The value of resources contributed from within the region to achieve the outputs | | |
| 1. Floodwater retarding structures and Long Lake Structure | | |
| Project installation 1/ | 5,970 | 10,140 |
| Project administration 1/ | 180 | 2,035 |
| O&M | 1,530 | 0 |
| Total adverse effects | 7,680 | 12,175 |
| Net beneficial effects | 44,440 | -12,175 |

1/ Amortized for 100 years @ 5 5/8 percent interest.

January 1975

SELECTED PLAN

REGIONAL DEVELOPMENT ACCOUNT

Brillion Watershed, Wisconsin

| Components | Measures of Effects: State of Wisconsin | Measures of Effects: Rest of Nation |
|---|---|---|
| Employment: | | |
| Beneficial effects: | | |
| A. Increase in number and types of jobs | | |
| 1. Employment for project construction | 8 skilled jobs for 1 year | - |
| 2. Employment for O&M | 8 semiskilled jobs for 1 year | - |
| 3. Indirect and induced employment for project installation and output of project's goods and services | 0.2 permanent semiskilled jobs | - |
| | 3 permanent semiskilled jobs | - |
| | 1 permanent skilled job | - |
| Total beneficial effects | 1 permanent skilled | - |
| | 3.2 permanent semiskilled jobs | - |
| | 8 skilled jobs for 1 year | - |
| | 8 semiskilled jobs for 1 year | - |
| Employment: | | |
| Adverse effects: | | |
| A. Decrease in number and types of jobs | - | - |
| Total adverse effects | - | - |
| Net beneficial effects | 1 permanent skilled | - |
| | 3.2 permanent semiskilled jobs | - |
| | 8 skilled jobs for 1 year | - |
| | 8 semiskilled jobs for 1 year | - |



January 1975

SELECTED PLAN

REGIONAL DEVELOPMENT ACCOUNT

Brillion Watershed, Wisconsin

| Components | Measures of Effects: State of Wisconsin | Measures of Effects: Rest of Nation |
|---|---|---|
| Regional Economic Base and Stability: | | |
| Beneficial Effects: | The project will provide flood protection to an estimated 89 homes, 18 businesses, and 3 agricultural properties with an estimated value in excess of $30,000,000. | - |
| Adverse Effects: | - | - |
| Population Distribution: | | |
| Beneficial Effects: | The project will create 1 permanent skilled job, 3.2 permanent semiskilled jobs, 8 short-term skilled jobs, and 8 short-term semiskilled jobs in an area where 12 percent of the families have incomes less than the national poverty level. This project is located in an area where approximately 15 percent of the labor force is employed in agriculture as compared to 6.5 percent in the rest of the state. | - |
| Adverse Effects: | - | - |

SELECTED PLAN

SOCIAL WELL-BEING

Brillion Watershed, Wisconsin

| Components | Measures of Effects |
|---|---|
| Beneficial and Adverse Effects: | |
| A. Real income distribution | 1. Create 4.2 low to medium income permanent jobs for area residents |
| | 2. Create regional income benefit distribution of $47,790 annual flood damage reduction benefits by income class as follows: |

| Income Class (Dollars) | Percentage of Adjusted Gross Income In Class | Percentage Benefits In Class |
|---|---|---|
| Less than 3,000 | 10 | 5 |
| 3,000-10,000 | 39 | 50 |
| More than 10,000 | 51 | 45 |

3. Local costs to be borne by region total $7,680 annually with distribution by income class as follows:

| Income Class (Dollars) | Percentage of Adjusted Gross Income In Class | Percentage Contributions In Class |
|---|---|---|
| Less than 3,000 | 10 | 5 |
| 3,000-10,000 | 39 | 50 |
| More than 10,000 | 51 | 45 |

| Components | Measures of Effects |
|---|---|
| B. Life, health, and safety | 1. Future threats of flood loss will be reduced. The project will provide benefits to 89 residential and 18 business properties in the urban areas of Brillion and Long Lake. Reduction in depth of flooding will reduce threat of damage to 10 road and bridge locations and a 103-acre flood plain. |

# Brillion Watershed
Calumet and Manitowoc Counties, Wisconsin

Prepared Under the Authority of the Watershed
Protection and Flood Prevention Act (Public Law 566,
83d Congress, 68 Stat. 666), as amended

Prepared by
Calumet and Manitowoc County
Soil and Water Conservation Districts

With Assistance By
U.S. Department of Agriculture, Soil Conservation Service
U.S. Department of Agriculture, Forest Service
U.S. Department of the Interior, Fish and Wildlife Service
State of Wisconsin Board of Soil and Water Conservation Districts
Brillion Watershed Association
Wisconsin Department of Natural Resources
University of Wisconsin Extension

January 1975

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# WATERSHED WORK PLAN AGREEMENT

between the

Calumet County and Manitowoc County
Soil and Water Conservation Districts
(hereinafter referred to as the Sponsoring Local Organization)

State of Wisconsin

and the

Soil Conservation Service
United States Department of Agriculture
(hereinafter referred to as the Service)

Whereas, application has heretofore been made to the Secretary of Agriculture by the Sponsoring Local Organization for assistance in preparing a plan for works of improvement for the Brillion watershed, State of Wisconsin, under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress; 68 Stat. 666), as amended; and

Whereas, the responsibility for administration of the Watershed Protection and Flood Prevention Act, as amended, has been assigned by the Secretary of Agriculture to the Service; and

Whereas, there has been developed through the cooperative efforts of the Sponsoring Local Organization and the Service a mutually satisfactory plan for works of improvement for the Brillion watershed, State of Wisconsin, hereinafter referred to as the watershed work plan, which plan is annexed to and made a part of this agreement;

Now, therefore, in view of the foregoing considerations, the Sponsoring Local Organization and the Secretary of Agriculture, through the Service, hereby agree on the watershed work plan, and further agree that the works of improvement as set forth in said plan can be installed in about 4 years.

It is mutually agreed that in installing and operating and maintaining the works of improvement substantially in accordance with the terms, conditions, and stipulations provided for in the watershed work plan:

1. The Sponsoring Local Organization will acquire, with other than Public Law 566 funds, such land rights as will be needed in connection with the works of improvement. (Estimated cost $105,700).

2. The Sponsoring Local Organization assures that comparable replacement dwellings will be available for individuals and persons displaced from dwellings, and will provide relocation assistance advisory services and relocation assistance, make the relocation payments to displaced persons, and otherwise comply with the real property acquisition policies contained in the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646, 84 Stat. 1894) effective as of January 2, 1971, and the Regulations issued by the Secretary of Agriculture pursuant thereto. The costs of relocation payments will be shared by the Sponsoring Local Organization and the Service as follows:

| | Sponsoring Local Organization (Percent) | Service (Percent) | Estimated 1/ Relocation Payment Costs (Dollars) |
|---|---|---|---|
| Relocation Payments | 52.8 | 47.2 | 0.00 |

1/ Investigation has disclosed that under present conditions the project measures will not result in the displacement of any person, business, or farm operation. However, if relocations become necessary, relocation payments will be cost-shared in accordance with the percentages shown.

3. The Sponsoring Local Organization will acquire or provide assurance that landowners or water users have acquired such water rights pursuant to State law as may be needed in the installation and operation of the works of improvement.

4. The percentages of construction costs of structural measures to be paid by the Sponsoring Local Organization and by the Service are as follows:

| Works of Improvement | Sponsoring Local Organization (percent) | Service (percent) | Estimated Construction Cost (dollars) |
|---|---|---|---|
| Single-Purpose Flood Retarding Structures | 0 | 100.0 | 118,760 |
| Long Lake Outlet | 0 | 100.0 | 42,260 |

5. The percentages of the engineering costs to be borne by the Sponsoring Local Organization and the Service are as follows:

| Works of Improvement | Sponsoring Local Organizations (percent) | Service (percent) | Estimated Engineering Cost (dollars) |
|---|---|---|---|
| Single-Purpose Flood Retarding Structures | 0 | 100.00 | 14,250 |
| Long Lake Outlet | 0 | 100.00 | 4,240 |

6. The Sponsoring Local Organization and the Service will each bear the costs of Project Administration which it incurs, estimated to be $3,200 and $36,000 respectively.

7. The Sponsoring Local Organization will obtain agreements from owners of not less than 50 percent of the land above each reservoir and floodwater retarding structure that they will carry out conservation farm or ranch plans on their land.

8. The Sponsoring Local Organization will provide assistance to landowners and operators to assure the installation of the land treatment measures shown in the watershed work plan.

9. The Sponsoring Local Organization will encourage landowners and operators to operate and maintain the land treatment measures for the protection and improvement of the watershed.

10. The Sponsoring Local Organization will be responsible for the operation and maintenance of the structural works of improvement by actually performing the work or arranging for such work in accordance with agreements to be entered into prior to issuing invitations to bid for construction work.

11. The costs shown in this agreement represent preliminary estimates. In finally determining the costs to be borne by the parties hereto, the actual costs incurred in the installation of works of improvement will be used.

12. This agreement is not a fund obligating document. Financial and other assistance to be furnished by the Service in carrying out the watershed work plan is contingent on the appropriation of funds for this purpose.

    A separate agreement will be entered into between the Service and the Sponsoring Local Organization before either party initiates work involving funds of the other party. Such agreement will set forth in detail the financial and working arrangement and other conditions that are applicable to the specific works of improvement.

13. The watershed work plan may be amended or revised, and this agreement may be modified or terminated only by mutual agreement of the parties hereto except for cause. The Service may terminate financial and other assistance in whole, or in part, at any time whenever it is determined that the Sponsoring Local Organization has failed to comply with the conditions of this agreement. The Service shall promptly notify the Sponsoring Local Organization in writing of the determination and the reasons for the termination, together with the effective date. Payments made to the Sponsoring Local Organization or recoveries by the Service under projects terminated for cause shall be in accord with the legal rights and liabilities of the parties.

14. No member of or delegate to Congress, or resident commissioner, shall be admitted to any share or part of this agreement, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this agreement if made with a corporation for its general benefit.

15. The program conducted will be in compliance with all the requirements respecting nondiscrimination as contained in the Civil Rights Act of 1964 and the regulations of the Secretary of Agriculture (7 C.F.R. 15.1-15.12), which provide that no person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any activity receiving Federal financial assistance.

16. This agreement will not become effective until the Service has issued a notification of approval and authorizes assistance.

Calumet County Soil and
Water Conservation District
Courthouse
Chilton, Wisconsin 53014

By Mike Koeppel

Title Chairman

Date March 26, 1975

The signing of this agreement was authorized by a resolution of the governing body of the Calumet County Soil and Water Conservation District adopted at a meeting held on March 26, 1975.

George Hostettler
Secretary, Calumet County
Soil and Water Conservation
District

Chilton Rt-1 53014.
Address Zip Code

Date 3-26-75.

Manitowoc County Soil and
Water Conservation District
County Building
Manitowoc, Wisconsin 54220

By Vernon P. Ebenhoe

Title Chairman

Date March 25, 1975

The signing of this agreement was authorized by a resolution of the governing body of the Manitowoc County Soil and Water Conservation District adopted at a meeting held on March 25 1975

Dale Schmook
Secretary, Manitowoc County
Soil and Water Conservation
District

1701 Michigan Ave.
Manitowoc WI 54220
Address Zip Code

Date March 25 1975

Appropriate and careful consideration has been given to the environmental statement prepared for this project and to the environmental aspects thereof.

Soil Conservation Service
United States Department of Agriculture

Approved by: Richard W. Akeley
State Conservationist

March 27, 1975
Date

# WATERSHED WORK PLAN

# BRILLION WATERSHED

# CALUMET AND MANITOWOC COUNTIES,

# WISCONSIN

January 1975

## SUMMARY OF PLAN

Brillion watershed has a drainage area of 13,811 acres or 21.6 square miles of which 2,291 acres are located in northwestern Manitowoc County and 11,520 acres are located in northeastern Calumet County.

The Calumet and Manitowoc County Soil and Water Conservation Districts, sponsoring local organization, developed this work plan. The Brillion Watershed Association, though not a sponsor, contributed significantly to its preparation. Technical assistance was provided by the Soil Conservation Service and the Forest Service of the U.S. Department of Agriculture. Other contributing agencies include the Wisconsin Board of Soil and Water Conservation Districts, the Wisconsin Department of Natural Resources, the University of Wisconsin Extension, and the Fish and Wildlife Service of the U.S. Department of the Interior.

Frequent and severe floodwater damage is the principal problem in the Brillion watershed. Damages have occurred in the city of Brillion and to residences located on Long Lake. Floodwaters have destroyed crops and pasture, damaged equipment, washed out roads, delayed plantings, hindered harvest operations, depressed crop yields, and deposited debris on crop and pasture land.

Approximately 850 acres of cropland need some drainage to achieve better agricultural production.

Works of improvement proposed in this plan include land treatment and structural measures. The total project installation cost is estimated to be $537,970, of which $213,560 is for land treatment and $324,410 is for structural measures.

-Summary-

Land treatment measures to be applied will reduce erosion, increase infiltration, protect and improve fish and wildlife habitat, and protect and develop woodland resources.

The installation cost to landowners for land treatment is estimated to be $166,720. The cost of technical assistance for planning and applying land treatment measures is estimated to be $46,840. This includes $38,220 of Public Law 566 funds to support accelerated land treatment. The Soil Conservation Service will provide $5,100 and the Forest Service will provide $3,520 in cooperation with the State of Wisconsin under the present program of assistance.

The proposed structural works of improvement consist of two single-purpose floodwater retarding structures and a lake level outlet control structure that includes 0.5 mile of channel work.

The installation of all works of improvement including structures and land treatment will be accomplished during a 4-year period.

Public Law 566 costs for structural measures are estimated to be $215,510. Other funds for the proposed structural measures, estimated to be $108,900, will be furnished by the Calumet and Manitowoc County Boards, the city of Brillion, and others.

Planned structural measures will provide average annual benefits of $52,120. This includes primary benefits of $47,790 and local secondary benefits of $4,330.

The estimated average annual cost of structural works of improvement is $19,855. This includes annual operation and maintenance costs estimated to be $1,530.

The benefit-cost ratio for structural measures is 2.6 to 1.0. When local secondary benefits are excluded, the benefit-cost ratio is 2.4 to 1.0.

The Calumet and Manitowoc County Soil and Water Conservation Districts will be responsible for the construction, operation, and maintenance of the structural works of improvement.

The project will have an impact on the environment by substantially reducing erosion, sedimentation, and floodwater damages. Wildlife habitat will be increased or improved with the addition of 10 acres of wetland, 48 acres of pool surface, and the stabilization of Long Lake. The project will result in a loss of about 122 acres of cropland and 8 acres of forest land. About 80 acres of grassland will be lost or reduced in quality by the project.

## WATERSHED RESOURCES
## ENVIRONMENTAL SETTING

### Physical Resources

The Brillion watershed, located in east-central Wisconsin, has a drainage area of 13,811 acres or 21.6 square miles 1/. About 11,520 acres are in northeastern Calumet County and 2,291 acres are in northwestern Manitowoc County. The irregularly shaped watershed is about 8 miles long and 5 miles wide.

Brillion, the only incorporated community, is centrally located in the watershed. Brillion is about 25 miles south of Green Bay and 100 miles north of Milwaukee. The western boundary of the watershed is approximately 10 miles from Lake Winnebago. The eastern boundary is approximately 20 miles from the shores of Lake Michigan.

The rural population of the watershed is estimated to be 1,450. The population of Brillion is 2,588 (1).

The watershed is within the Great Lakes Region as delineated by the Water Resources Council. The watershed is also within the Southeast Wisconsin Rivers basin where an intensive study of water and related land resources was conducted by the United States Department of Agriculture. The watershed is located within the East Central Wisconsin and Bay-Lake Regional Planning Areas and is included in the Lake Winnebago District of the Wisconsin Uniform State Districts.

Flooding from runoff produced by snowmelt and/or rainfall occurs annually. These floods cause extensive damage to industrial, residential, and commercial properties. Brillion has a long history of damaging floods. Approximately 30 acres of urban and built-up land are subject to flooding during severe storm events.

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1/ All information and data, except as otherwise noted by reference to source, were collected during the watershed planning investigation by the Soil Conservation Service and Forest Service, U.S. Department of Agriculture.

Inadequate channel capacity and lack of adequate outlets cause interrelated floodwater and drainage damages to 850 acres of cropland, mainly northwest of Brillion. See figure 5.

*FREQUENT FLOODING OCCURS IN RURAL AREAS.*

Upland sheet erosion occurs throughout the watershed. Gross erosion for the upland agricultural area averages about 3.1 tons per acre per year. Sedimentation in the channels and flood plains poses a threat to fish and wildlife habitat as well as to agricultural use. Spring Creek delivers approximately 7,200 tons of sediment annually to the Brillion Marsh.

The topography is characterized by irregular, rolling, low-lying uplands; flat, broad, poorly defined drainageways; and nearly level lake plains. Maximum relief is about 125 feet. The highest point in the watershed is about 925 feet above mean sea level. It is slightly less than 800 feet above mean sea level where Spring Creek joins the North Branch of the Manitowoc River.

The Kewaunee, Manawa, and Poygan soil series make up about 7.5 percent of the Brillion watershed. Adrian, Houghton, Boyer, Mundelein, and Yahara are some of the minor soil series.

The Kewaunee series consists of well and moderately well drained, gently sloping and sloping soils formed in reddish clay glacial till. The Manawa series consists of somewhat poorly drained, nearly level soils formed in the same till as the Kewaunee soils. Soils of the Poygan series are poorly drained, nearly level or slightly concave and formed in the same reddish clay till.

The Adrian series consists of very poorly drained, nearly level soils formed in 30 to 40 inches of muck underlain by medium sand. The Houghton series consists of very poorly drained, nearly level soils formed in more than 51 inches of muck. The Boyer series consists of well drained, gently sloping and sloping soils formed in loamy outwash over calcareous sand and gravel. The Mundelein series consists of somewhat poorly drained, nearly level soils formed in stratified silt and clay. The Yahara series consists of somewhat poorly drained, nearly level soils formed in loamy outwash over calcareous fine sand and silt.

No class I agricultural soils are found in this watershed. All of the soils have slight to severe limitations for agricultural use. The Kewaunee and Boyer soils have a water erosion hazard and fall into IIe, IIIe, or IVe classes and subclasses. The Manawa, Poygan, Yahara, and Mundelein soils need supplemental drainage and are in capability class II with a w subclass. The organic soils have a wind erosion hazard, need drainage, and are subject to settling when drained. They fall into class IV and subclass w land (3).

Most of the soils in this watershed are good to fair for agricultural use. Many of them, especially the clayey and wet soils, have severe limitations for building sites. The soils in the watershed are also generally well suited for woodland and wildlife.

The watershed is on the glacial drift covered backslope of the Niagara cuesta. The upper surface of a generalized geologic section is a thin mantle of Recent soils and alluvium developed from Pleistocene deposits of the Wisconsin Stage of glaciation. The glacial drift is as much as 200 feet in thickness. The main glacial deposits are ground moraine (till), lake bed deposits, and outwash. Two well-defined substages of the Wisconsin Stage are present in the watershed. The upper drift is the Valders substage (red glacial drift) and the underlying drift is the Cary substage. The deposits of the Pleistocene epoch are underlain by the Niagara dolomite of Silurian age. The Niagara dolomite is underlain by a thick sedimentary sequence of Cambro-Ordovician Paleozoic rocks. These rocks are underlain by the Precambrian igneous basement rock, a granite present about 1,200 feet beneath the surface (4).

Silurian rocks outcrop in the watershed but are mostly obscured by Recent soils, alluvium, and colluvium, and Pleistocene outwash, lacustrine clay, and ground moraine. The best profile of an outcrop is a large quarry northeast of U.S. Highway 10 in Brillion. The quarry has been operated for many years and occupies about 40 acres. At least a 50-foot section of Silurian (Niagara) dolomite has been exposed. It is overlain by soils, 6 feet of red clayey till, and 9 feet of gray till. The rock is a thick-to-thin bedded calcitic dolomite with some shale and chert zones. Fossils are scarce. There are two sets of joints at approximate right angles with more prominent east-west joints or fractures. The rock has no appreciable dip, but the regional dip of the Paleozoic strata is east-southeast. Glacial striae at the quarry have a south 55 degrees east trend.

Commercial mineral production is limited and consists of sand, gravel, and dolomite. The large quarry in Brillion furnishes some road material. Small sand and gravel pits are common but much of the pit material has a high silt content and is seldom used.

Brillion watershed has a humid continental climate with a large variation in temperature. January, the coldest month, has an average

temperature of 16 degrees Fahrenheit ($^{O}$F). July, the warmest month, has an average temperature of 70$^{O}$F. Average annual precipitation is 30 inches. Approximately 70 percent of the precipitation occurs as rain during the growing season of May through October. Local storms with high intensity rainfall are common during the summer months. The first killing frost in the fall is in early October and the last killing frost is in mid-May. Winter prevailing winds are northwesterly. Summer prevailing winds are southwesterly (5).

Precipitation of 2.25 inches in a 24-hour period occurs annually. Runoff from storm events of this magnitude causes flooding in the watershed. A 24-hour rainfall of 3.70 inches will occur on an average of once every 10 years. Rainfall from storms having a frequency of once in 10 to 100 years (3.70 to 5.15 inches) causes extensive flood damages. (6).

Spring Creek, a modified, well-defined stream, rises in Calumet County in section 11, T. 20N, R. 20E. The stream is intermittent in its headwaters. It flows in a generally southwesterly direction 9 miles into the North Branch Manitowoc River in section 4, T.19 N., R. 20E. An intermittent stream drains Round Lake, Long Lake, Becker Lake, and Grass Lake and joins Spring Creek in Brillion Marsh below Brillion. The North Branch Manitowoc River joins the Manitowoc River and discharges into Lake Michigan. The drainage pattern in the watershed is random.

Streambank erosion is minor because of the relatively flat stream gradients. Vegetation varies from sparse in recently altered reaches in the vicinity of the Brillion Iron Works to dense south of Water Street in Brillion. Grassland with scattered trees predominate on most streambanks throughout the watershed. Most streambanks are not pastured. The streambeds are mainly fine-grained materials, mostly silt.

Water quality in the streams varies by location and season. Water quality data has been collected by JFK Prep School (12), Brillion High School (18) (19), and the Soil Conservation Service (17). Test data from six grab samples taken by the University of Wisconsin-Stevens Point for the Soil Conservation Service on March 11, 1974, follow:

*SPRING CREEK BELOW BRILLION IRON WORKS*

*DRAINAGEWAY AND MARSH JUST ABOVE BECKER LAKE*

-Setting-

| Item | Unit | Site 1/ 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| Temperature | °C | 2 | 2 | 3 | 3 | 1 | 2 |
| Turbidity | JTU | 3 | 3 | 3 | 3 | 2.5 | 2.5 |
| pH | - | 7.9 | 7.8 | 7.8 | 7.8 | 7.5 | 7.6 |
| Conductivity | uMHOS | 520 | 570 | 580 | 750 | 380 | 275 |
| Alkalinity | mg/l | 200 | 222 | 218 | 221 | 126 | 116 |
| Total hardness | mg/l | 312 | 316 | 268 | 324 | 160 | 140 |
| B.O.D. | mg/l | 1.8 | 2.2 | 2.0 | 2.5 | 3.1 | 2.85 |
| Dissolved Oxygen | mg/l | 8.7 | 11.6 | 11.1 | 11.1 | 1.7 | 7.0 |
| C.O.D. | mg/l | 47.6 | 37.7 | 37.7 | 31.7 | 77.4 | 55.6 |
| Chloride | mg/l | 16 | 20 | 25 | 85 | 29 | 10 |
| Ortho P | mg/l | 0.060 | 0.070 | 0.107 | 0.094 | 0.132 | 0.080 |
| Total P | mg/l | 0.105 | 0.255 | 0.185 | 0.160 | 0.240 | 0.175 |
| $NH_3$ | mg/l | 0.14 | 0.07 | 0.14 | 0.07 | 0.28 | 0.18 |
| $NO_3$ - $NO_2$ | mg/l | 1.19 | 2.63 | 2.49 | 2.59 | 0.81 | 0.56 |
| Kjeldahl N | mg/l | 1.92 | 1.54 | 2.06 | 1.82 | 2.38 | 2.38 |
| Suspended solids | mg/l | 0 | 25 | 0 | 35 | 0 | 49 |
| Total solids | mg/l | 390 | 360 | 340 | 460 | 226 | 156 |
| Dissolved solids | mg/l | 412 | 335 | 364 | 425 | 264 | 107 |
| Fecal Coliforms | No/100 ml | 0 | 65 | 5,845 | 2,280 | 0 | 0 |

1/ Site locations are shown on the project map. Sites 1-4 are on Spring Creek at Rusch Road, County Trunk Highway PP, Water Street, and Sunset Drive, respectively. Sites 5 and 6 are at the inlet and outlet of Long Lake.

The Spring Creek samples (1-4) are all high in hardness, alkalinity, pH, and nutrients and fairly low in solids and biochemical oxygen demand. The Brillion High School and JFK Prep School found that hardness varied from 110 to over 750 parts per million and pH varied from 7.0 to 9.7. The source of nutrients in Spring Creek is unknown. It is unlikely to be from surface runoff at sites 1 and 2 since the fecal coliform counts are very low. The high fecal coliform counts at sites 3 and 4 indicate a large input somewhere between sites 2 and 3. This corresponds to an increase in Kjeldahl-N and ortho P with no increase in biochemical oxygen demand or other nutrient values. This section of stream would be considered unsafe for water sports where the body is in contact with the water.

The Brillion sewage treatment plant discharges into Spring Creek a block above Sunset Drive. The effluent has a definite effect on water temperatures. In the winter it rises and in the summer it is cooler. Hardness, chlorides, pH, and nutrients increase below the outfall (18) (19). Analyses of the samples at sites 5 and 6 above and below Long Lake show the water to be much lower in hardness and alkalinity than Spring Creek. They are low in oxygen and high in biochemical and chemical oxygen demand for the time of year. Nutrient values are quite high. Fecal coliforms were zero at both sites indicating little animal waste contamination at the time of sampling. Since site 5 had no suspended solids it points to little surface runoff.

Water supplies for most domestic and industrial needs are obtained from shallow to deep wells in river alluvium, glacial outwash, glacial drift, or in Paleozoic sandstones and limestones. Almost all ground water is hard, having over 400 parts per million of dissolved solids (7). Some commercial and residential water supplies are presently being softened.

The main agricultural use of ground water is for livestock watering. Two irrigation systems are presently operating within the watershed. One is a 10-acre system for strawberries. The other is a canning company waste water disposal system. Ground water supplies are adequate for future needs.

The existing municipal water supply, primarily from wells, is good. The population of Brillion is expected to increase by 30 percent by the year 2000. There is an adequate water supply for future demands.

Land use in the total watershed and the flood plain are shown in the following table:

| Land Use | Total Watershed Acres | Total Watershed Percent | Flood Plain Acres | Flood Plain Percent |
|---|---|---|---|---|
| Cropland | 9,600 | 70 | 850 | 55 |
| Grassland | 1,700 1/ | 12 | 290 | 19 |
| Forest Land | 850 2/ | 6 | 110 | 7 |
| Urban and Built-up | 670 3/ | 5 | 130 | 9 |
| Other | 991 4/ | 7 | 160 | 10 |
| TOTAL | 13,811 | 100 | 1,540 | 100 |

1/ Includes 230 acres type 2 and 200 acres type 6 wetlands.

2/ Includes 300 acres type 7 wetlands.

3/ Includes 30 acres type 2 wetlands.

4/ Includes 290 acres types 3, 4, and 5 wetlands; 191 acres lakes; and 510 acres roads, farmsteads, etc.

Approximately 850 acres of the watershed are forested. About 400 acres of forest lands are along drainageways and flood plains and 450 acres are on the uplands. The hydrologic conditions of these forest lands is good. Hydrologic condition is defined as the relative ability of specific combinations of soil and vegetative cover to absorb precipitation and retard runoff. It expresses the inter-relationship existing between the soil and forest cover, and their effect on the movement of precipitation on, into, and through the soil.

Wetlands are defined in Wetlands of the United States, Department of the Interior, Fish and Wildlife Service Circular 39 (8). An estimated 1,050 acres of wetlands are found in the watershed. These include 260 acres of type 2, 240 acres of type 3, 50 acres of types 4 and 5, 200 acres of type 6, and 300 acres of type 7. Type 1 wetlands were not inventoried.

The southeastern portion of the watershed has 5 lakes of glacial origin: Round Lake - 11 acres; Grass Lake - 20 acres; Boot Lake - 11 acres; Becker Lake - 32 acres; and Long Lake - 117 acres (9). Southwest of Brillion is a roughly triangular area of wetland that extends to the margin of the watershed and drains into the North Branch Manitowoc River.

## Present and Projected Population

The estimated 1970 population for the city and town of Brillion is 3,912. The 1990 projected population is 6,817, an increase of 74 percent. These projections are based on predictive equations incorporating the influence of community size, location, proximity to growing urban areas, and past growth trends from 1940 to 1970 (14).

## Economic Resources

Landownership in the Brillion watershed is generally private. Public land is limited to buildings, roads, and parks. The State of Wisconsin proposes to purchase and develop for waterfowl about 2,000 acres in the Brillion Marsh area including the lower reaches of Spring Creek. Land purchase is now underway. There are no Federal lands in the watershed.

The majority of the farm units are classed as family type farms. These farms use less than 1.5 man-years of hired labor. The average farm size is 90 acres. There are 139 farms in the watershed, 104 in Calumet County and 35 in Manitowoc County. Ninety-three percent of the landowners are cooperators with their local soil and water conservation district.

Agriculture is important in the Brillion watershed with the sale of livestock, poultry, and their products accounting for 91 percent of the cash farm income. Dairy products are the largest source of farm income. According to the 1969 U.S. Census of Agriculture, farms in Calumet County had average sales of $15,000, identical to the State average. The county average is typical of the watershed.

Principal crops grown are corn, oats, and hay. Sweet corn, peas, and beets are also grown. Average bottomland flood-free yields per acre are: corn - 90 bushels; oats - 80 bushels; and hay - 3.5 tons. Upland yields are: corn - 85 bushels; oats - 72 bushels; and hay - 2.5 tons. Almost all of the feed and grain crops grown are utilized on farms within the watershed. A common rotation in the flood plain is 2 years corn, 1 year oats, and 2 years hay. Upland rotations average 2 years corn, 1 year oats, and 3 years hay.

The number of farms in Calumet County declined between 1959 and 1969. At the same time, the average size of farms increased, as did the value of land. The value of agricultural land varies significantly. Average values are estimated at $350 per acre in the flood plain and $400 per acre in upland areas. Wildlife or wetland area values are estimated at $100 per acre. Land for new urban development has a value of $700 per acre.

Brillion watershed has an extensive network of roads. U.S. Highway 10 crosses the watershed in an east-west direction, passing through Brillion. State Highway 114 enters the watershed at its southern border and runs north to end at Brillion. County Trunk Highway PP bisects the northern half of the watershed in a north-south direction from Brillion. Additional town and county roads serve as good all year transportation routes. The Chicago and Northwestern Railroad is immediately south of and roughly parallel to U.S. Highway 10. This transportation network provides for the convenient and efficient movement of agricultural and manufactured items produced in the watershed.

Brillion watershed is in a strategic position between two expanding industrial areas, the Fox Valley corridor and the cities along Lake Michigan. About 380,000 people live within a 25-mile radius of Brillion (1). Calumet County is included in the Appleton-Oshkosh Standard Metropolitan Statistical Area.

Industry offers many opportunities for off-farm employment. Two important employers are the Brillion Iron Works, and the Ariens Company. Brillion Iron Works manufactures farm equipment and several nonagricultural items. The Ariens Company manufactures lawn and garden equipment. There are numerous smaller, but important, employers such as Larson Canning Company, Zander Press, Rent-a-Truck, and various retail outlets.

Agriculture remains a substantial industry in the area, employing about 15 percent of the labor force as compared with 6.5 percent of the labor force in the State of Wisconsin. Manufacturing has taken the lead as the largest employer, utilizing about 42 percent of the labor force as compared with 31 percent of the labor force in the State of Wisconsin (10). Calumet County has 159 manufacturing jobs per thousand residents compared with the State average of 118. This is typical of the watershed.

Median family income in Calumet County in 1969 was $10,130 as compared to the State median of $10,070, which is typical of the watershed. (10) The county's retail sales are smaller than the State average. Per capita sales of $1,270 compare with the State average of $1,580. The strongest retail lines are in lumber, hardware, and farm equipment. The watershed is not within an economically depressed area.

Approximately 32 family farms sustain floodwater damages. Many family farms have agricultural water management problems. Fifty-six properties within the urban area have floodwater damages with present conditions.

A majority of the forest land is in private ownerships. The average forest ownership is about 20 acres. Some forest land occurs on the portion of the State-owned Brillion Marsh Wildlife Management Area that is in the watershed.

Markets for saw logs and veneer are very good, but the values of forest for wildlife and watershed protection currently take precedence.

Fire protection is provided through the Department of Natural Resources coordination of the respective town fire departments. All forest areas are adequately protected.

Contributions of forest resources to the local economy are primarily recreational. They provide wildlife habitat, variety to the landscape, and shelter for homes, parks, and picnic areas.

## Plant and Animal Resources

About 450 upland acres support stands of the oak-hickory and beech-birch-maple types. The 400 acres in the more poorly drained sites support beech-birch-maple and elm-ash-cottonwood types that are useful as wildlife habitat. Upland areas are largely used for recreation, wildlife, watershed protection, and esthetics.

Wetlands, which furnish important wildlife habitat, occupy about eight percent of the area. Most of the wetlands are within the Brillion Marsh portion of the watershed. Overall, the amount of wetlands remains relatively constant. However, by definition the types of wetland are changing.

A land use change from cropland to idle land, notably in the Brillion Marsh is increasing the amount of habitat available for wildlife. The water surfaces of Brillion Marsh and Long Lake are higher today than 30 years ago because of sediments, especially decaying vegetation. The marsh and associated grasslands along with the five glacier lakes provide excellent waterfowl habitat.

The five lakes, with a combined surface area of 191 acres, provide valuable fisheries. Northern pike, largemouth bass, panfish, crappie, and carp are common species. Most of the lakes are highly fertile and support an abundance of carp. Grass Lake and Boot Lake are shallow with depths of 3 and 16 feet respectively. Becker and Round Lakes, at 51 feet, are the deepest. Long Lake is 37 feet deep.

The present stream fishery is negligible. Severe annual winterkills are experienced in the lower reach of Spring Creek. Most of the streams are managed for forage and rough fish. Northern pike and crappie are found within limited reaches of the stream. The estimated 6 miles of perennial streams have a surface area of 13 acres.

A variety of wildlife inhabits the Brillion watershed. The most common game species are deer, rabbits, squirrels, raccoons, opossums, foxes, waterfowl, woodcock, pheasants, and Hungarian partridge. Migrating birds using the Lake Michigan shoreline are common visitors to the watershed in the spring and fall. The Arctic peregrine falcon and the southern bald eagle are threatened species that may occasionally visit the watershed (13).

## Recreational Resources

Opportunities for water-based recreation in and near Brillion are adequate for present and future needs. Lake Michigan and Lake Winnebago are within 20 miles of Brillion. Brillion maintains a highly developed city park and an 18-hole golf course. The Wisconsin Department of Natural Resources will provide a major recreational resource when it completes a proposed 5,779-acre public development as part of the Brillion Marsh Game Management Area. It will provide opportunities for boating, fishing, hunting, hiking, and nature studies.

The five glacial lakes with a combined area of 191 acres provide limited opportunities for recreation. Fishing pressure is moderate. Long Lake is the most highly developed lake. The Manitowoc County Park Board maintains a park and public boat landing on the northeast side of the lake. The area surrounding Long Lake has been divided into residential plots. Land disturbance associated with the installation of trailers and cabins has increased erosion and silt deposition in the lake. Septic tank effluent has polluted the lake water. Lake treatment during the last 5 years has been necessary to reduce algae. Long Lake's fishery and water quality have deteriorated because of heavy rough fish populations.

## Archeological and Historical Resources

The Director of the State Historical Society (State Historic Preservation Officer) and local residents were consulted to determine any areas with archeological, historical, scientific, or scenic values in the watershed. A field survey of possible archeological sites was conducted by the State Historical Society. Local residents identified the lime kiln ruins in Brillion as being a potential historical site. No areas are listed in the National Register of Historic Places (15) or by the Wisconsin Scientific Areas Preservation Council (16).

## Soil, Water, and Plant Management Status

The U.S. Census of Agriculture shows a downward trend in the amount of farm land and an increase in the average farm size.

The average cropland per farm is increasing, indicating a trend toward consolidation of smaller farm units. Urban and built-up areas and other land uses are increasing.

A substantial decrease in crop yields and higher production costs have resulted from delays in planting, interrupted tilling and harvesting operations, and stunted crop growth because of flooding and inadequate drainage. Poor drainage has impeded proper land use and treatment on approximately 850 acres of cropland. Many small wet areas require drainage in order to convert poorly drained cropland to more productive fields. These areas are small surface depressions, flat poorly defined drainage ways, seepage areas, and patches of poorly drained soils. Drainage is done on some of these areas by surface and subsurface drains. In many cases, tiled sod waterways are used.

The Calumet and Manitowoc County Soil and Water Conservation Districts have been active in conservation and resource planning. They work with individuals, groups, and governmental units in the proper planning and application of soil and water conservation practices. Both districts have been active in the establishment and development of the Brillion watershed.

The two districts in cooperation with the watershed farmers have an active land treatment program. One hundred and thirty of the 139 farmers are cooperators with their local soil and water conservation districts. They own and operate 11,650 acres, or 84 percent of the watershed. Thirty-eight cooperators have conservation plans on 4,182 acres, or 30 percent of the watershed. The percent of planned land treatment measures installed on their farms to date are: contour farming -30 percent; grassed waterways or outlets - 35 percent; and drains - 35 percent. Conservation cropping systems are being followed on 30 percent of the cropland in the watershed.

Forest stands are adequately treated. Woodland grazing has almost ceased.

During the past 10 years, five forest land plans have been prepared. These plans were concerned with harvesting, tree planting, and timber stand improvement.

## WATER AND RELATED

## LAND RESOURCE PROBLEMS

### Land and Water Management

Important problems include sheet erosion, surface runoff, and improper land management. Land treatment needs include the orderly removal of surface runoff, the control of erosion and sedimentation, the preservation of soil fertility, and the management of water to maintain a desirable soil-water relationship.

The flooding and impaired drainage have resulted in the inefficient use of land, labor, and capital in the uplands and in the potentially benefited area.

Poor drainage and flooding of the productive soils in the flood plain have pushed intensive cultivation up the slopes causing increased sheet erosion.

Zoning and land use planning activities have not been coordinated. The amount of land treatment measures applied has been limited because of the relative inability of the small landowners and operators to finance installation. Generally, land treatment measures applied to the land have been highly dependent on cost-share funds available.

Forest land needs pertain mostly to diversion of productivity into food and shelter for wildlife. Forest land use is presently near optimum. Management plans are needed on 800 acres of forest land to assist owners in obtaining maximum recreational use and watershed protection from these lands. An additional 50 acres of reforestation is needed. Unless greater financing and agency services are provided, no significant increase in forest land treatment is probable.

## Floodwater Damage

Floodwater damage is the primary problem in the Brillion watershed. See figure 4. Historical records for Spring Creek at Brillion show frequent flooding. Roads have been barricaded and traffic re-routed many times because of floods. In some years flood plains have been inundated several times. Floods have destroyed crops and pasture, washed out fences, damaged roads and bridges, damaged equipment, inundated urban areas, flooded factories, damaged public utilities, and deposited debris on cropland and pasture. Fish and wildlife habitat has been damaged by floodwaters.

The area subject to inundation is approximately 1,540 acres. Thirty-two farms are subject to flooding. Approximately 38 residences and 18 businesses in Brillion sustain floodwater damages. See figure 5. Two homes, 17 trailers, and 32 summer cottages on Long Lake are subject to flooding.

Flood plain land has changed from cropland to pasture because of frequent flooding. It is estimated that small frequent floods up to 10-year frequency account for 59 percent of the total average annual damages.

Most urban damage occurs along the main channel of Spring Creek. The western portion of Brillion also experiences flooding from the unnamed tributary in that area. In some years flood plain land has been inundated several times. The Brillion Iron Works, which spans a portion of the channel in Brillion, is flooded frequently. The unnamed tributary at the western edge of the city causes occasional flooding on the grounds of the Ariens Company.

Severe flood events were experienced in 1924, 1942, 1966, and 1969. A flood of the magnitude of the 1924 event is expected to occur on the average of once every 25 years.

*FLOOD OF 1969*

The key flood studied occurred in 1969. A flood of this size can be expected to occur on the average of once every 5 years. Over 250 acres including about 65 acres of cropland and pasture were inundated along Spring Creek. Flooding caused damage to 17 homes and 4 commercial establishments in Brillion. In addition, public utilities, park grounds, streets, roads, and bridges were damaged. Damage to existing agricultural and nonagricultural properties for a future storm of this magnitude would be approximately $52,000.

Estimated average annual damages by categories are as follows: urban - $41,140; crop and pasture - $1,260; roads and bridges - $1,720; and sediment - $550.

While the potential loss of life is high, there are no records of lives being lost because of floodwaters. Flooding causes physical and mental suffering to those directly involved. Septic tanks and outhouses around Long Lake are subject to flooding, causing a threat to public health.

-Problems-

Forest problems are encountered mainly in stands of the lowland types. Elm is dying from a variety of diseases, including Dutch elm disease. Maple and ash are encountering survival problems on the wetter sites. A 10-acre stand of elm-ash-maple type adjacent to Long Lake is showing increased mortality. This is because of a rise in the lake level over the past few years.

## Erosion Damage

The watershed topography consists of gentle slopes and rolling lakebed plains. Sheet erosion from cropland is the predominant type of erosion. Gully, streambank, and roadside erosion also occur. Construction areas, though small in size, often are severely eroded. Erosion may be as much as 100 tons per acre per year on these areas. A few small gullies occur in the uplands. Occasional raw banks with an average height of about 4 feet occur along the main channels. Roadside erosion is not considered a severe problem. It occurs mostly on town roads.

Upland sheet erosion in the watershed is by far the most serious form of erosion in terms of tons of soil loss. Some cropland is currently contributing up to 13 tons per acre per year. The watershed average for cropland is about 3.1 tons per acre per year This amounts to 2.4 inches of soil loss in 100 years. The erosion rate was higher in the past. Gross erosion of agricultural land has been reduced to the present rate by the installation of soil and water conservation practices.

Bank slumps and slides occur along drainageways and manmade outlet channels. These slumps and slides plug drainageways and increase the need for maintenance and cleanout. Bank slumps and slides, along with sediment deposition in drainageways and manmade outlet channels, are a major problem.

Large areas of the watershed are low-to-flat lying glacial lakebeds. These are sediment deposition areas rather than erosion areas. A minor amount of wind erosion does occur in the watershed. No separate monetary value was determined for sheet, streambank, gully, roadside, or other types of erosion.

## Sediment Damage

Sediment laden floodwater is the principal source of sediment damages. The major soils of the watershed are silts and clays that are carried in suspension by floodwaters. Sheet erosion from cropland is the

*SPRING CREEK FLOOD OF JUNE 1969*
*DAMAGED BRILLION IRON WORKS*

principal contributor of sediment. Gully, streambank, and roadside erosion are other sources. Excess runoff transports these sediments from the uplands to downstream areas of deposition. Generally, the area of sediment damage is the same area damaged by floodwaters.

In agricultural areas sediment is deposited on crops and pasture, retarding plant growth. Fine sediments deposited on cropland decrease water infiltration causing ponding that results in drowned crops. Pasture plants covered with a fine film of sediment are not palatable. This condition exists until the sediment is washed off by rainfall. Sediments deposited in low gradient ditches and watercourses decrease water flow and require more frequent ditch cleanout.

In urban areas sediment is deposited inside homes and commercial and public buildings. This sediment causes damage to the buildings and contents. Removal of sediment from appliances, building surfaces, and furnishings is time consuming and expensive. This

is also true of sediment deposited on lawns, gardens, and driveways. Sediment deposited on parks, roads, and other public properties must be removed, increasing taxes.

Sediment-laden floodwaters damage automobiles and farm machinery. Normal farm operations are disrupted by the dismantling and repair of machinery damaged by sediment. Debris carried by floodwaters is deposited or snagged by objects such as culverts, bridges, buildings, shrubs, and trees. The snagged debris often causes additional secondary damage such as washouts of plugged bridges and culverts.

The major sediment deposition areas are the Brillion Marsh and the drainageways adjacent to the marsh. Swamping caused by sediment deposited in these areas retards drainage and modifies wildlife wetland habitat. Long Lake has a sediment problem from continued construction in its watershed.

The predicted annual delivery of sediment to the Spring Creek bridge below Brillion is 7,200 tons for present conditions. Thus, sediment by volume is the greatest pollutant in Spring Creek.

Average annual downstream sediment damage is estimated to be $550. Present and future sediment damages associated directly with floodwater damage are included as floodwater damage in the figures given in table 5.

## Drainage Problems

Lack of drainage has presented a major obstacle to agricultural production on approximately 850 acres of cropland, notably in section 22, T.20N., R.20E. Nearly 1,330 acres of grassland are also affected by seasonably high water tables. Wet or ponded conditions affect normal farming operations for extended periods of time. Wet conditions cause increased production costs. Increased costs result from additional time and materials required to perform farm operations and from the duplication of various phases of the production process.

Wet conditions also cause depressed crop yields. Flood-free crop yields on similar soils with and without adequate drainage are:

| Crop | Projected Yields With Drainage | Present Yields Without Drainage |
|---|---|---|
| Corn (bu/ac) | 130 | 75 |
| Oats (bu/ac) | 109 | 79 |
| Hay (tons/ac) | 4.6 | 2.6 |

About 400 acres of forest land are located in wet areas. Timber species on these sites are not desired by sawlog and veneer markets.

Local efforts to alleviate the wet soil problem have been attempted by individual farmers. Drainage field ditches were the predominant means of treatment. These measures did not completely solve the drainage problems. Further local efforts to improve the situation have been suppressed for lack of an adequate drainage outlet.

Drainage measures needed include land smoothing, surface drains, tile drains, water control gates, and pumping plants. Installation of these measures may occasionally require group action. Land treatment measures to reduce runoff and sediment are needed in conjunction with the drainage improvements.

Soils in the problem area are deep, somewhat poorly drained, nearly level loamy soils. The soils are 20-40 inches thick overlying calcareous silt and fine sand on lacustrine plains. These are moderately permeable soils with high available water capacity. Surface drainage is feasible if proper precautions are taken to stabilize the banks. Subsurface drainage ranges from feasible to not recommended due to instability of soil material.

It is estimated that the drainage problem depresses annual net farm income in the watershed, an average of $5,320.

## Plant and Animal Resource Problems

Heavy populations of rough fish are helping to degrade the Long Lake fishery and its water quality. They have been attracted to the lake because of its high fertility. Turbidity is increased by these fish.

No known rare or endangered animal species reside in the Brillion watershed (11). The Arctic peregrine falcon and southern bald eagle may be infrequent migrants.

## Water Quality Problems

Septic tank effluent poses a water quality problem for Long Lake during flood flows. The lake has been treated to reduce algae during the past 5 years.

The high fecal coliform counts in Brillion found during the water quality survey could pose a health hazard. Water contact sports may not be safe during times of such high counts. The source of the fecal coliforms is nonagricultural.

## PROJECTS OF OTHER AGENCIES

The Wisconsin Department of Natural Resources (DNR) is currently reviewing a proposal to develop and manage the Brillion Wildlife Area in Calumet County for the purposes of waterfowl production and outdoor recreation. Development of the wildlife area would include: acquisition of approximately 1,590 acres in Brillion and Rantoul Townships; creation of a 2,900-acre flowage on the north branch of the Manitowoc River involving a dike and water control structure; creation of a 125-acre flowage on Spring Creek involving a dike and water control structure; dredging of approximately 6,000 feet of the original bed of Spring Creek from the city of Brillion to a point within the marsh where Spring Creek is open water; construction of a dike parallel to the dredged Spring Creek channel for the entire distance of 6,000 feet that will permit separate manipulation of the water level in the two units; creation of 3 sub-impoundments of the main flowage involving dikes and water control structures; construction of potholes from 1/2 to 2 acres in size; conversion of 400 acres of sharecropped land to grassland; construction of 4 parking lots and 2 scenic overlooks; establishment of a wildlife refuge or closed area of approximately 2,600 acres; and construction of a nature study center and interpretive facilities. Management for waterfowl production would be to increase water-vegetation interspersion and to promote maximum growth of emergent food plants beneficial to waterfowl by water level manipulation within the impoundments. An environmental impact statement by the DNR is currently being prepared.

The city of Brillion has constructed a new channel to carry flows of Spring Creek from the Main Street bridge downstream to the city limits.

Calumet County has developed a proposed land use plan. A series of public information meetings will be held throughout the county prior to adoption of the plan.

No other Federal, State, or county works of improvement are known to be planned for the watershed.

## PROJECT FORMULATION

The Calumet County and the Manitowoc County Soil and Water Conservation Districts agreed in March and August of 1968 to serve as the sponsoring local organization for the Brillion watershed. The application for planning assistance was endorsed by the Brillion City Council, Brillion Iron Works, Ariens Company, Brillion Lions Club, Zander Press, Calumet County Bank, Brillion Conservation Club, and Brillion Chamber of Commerce. The towns of Brillion, Rantoul, Maple Grove, and Rockland also endorsed the application. Written notices of meetings and requests for information about the watershed were issued by the sponsors. Public meetings, steering committee meetings, and planning and coordinating meetings of the sponsors with State and local agencies were held. In February 1969 the application for assistance was approved by the Wisconsin Board of Soil and Water Conservation Districts. It was submitted to the U.S. Department of Agriculture, Soil Conservation Service, in March 1969.

A preliminary investigation was made by the watershed staff of the Soil Conservation Service in Wisconsin and it was reported in September 1969 that the project appeared to be feasible. A watershed association was formed in April 1970. In October 1970, the sponsoring local organization, the watershed association, and interested agencies were informed that planning authorization had been given to the Soil Conservation Service in Wisconsin to assist the local sponsors with the development of a work plan for watershed protection, flood prevention, and agricultural water management. The development of this work plan was accomplished with the assistance of public meetings, steering committee meetings, and with assistance from State and local agencies.

The Brillion watershed was investigated during the Southeast Wisconsin Rivers basin study and recognized as a project meriting early action.

## Objectives

The project objectives represent the wishes of the local people as outlined in the watershed application. The major objectives are to:

1. Establish land treatment and structural measures that will contribute directly toward watershed protection and flood prevention. The goal is to adequately protect 75 to 80 percent of the land by the end of the project installation period.

2. Reduce floodwater, erosion, and sediment damage to crops and pasture, equipment, and farm facilities.

3. Reduce floodwater inundation and sediment deposition to residential and commercial properties. The desired level of protection is the 100-year storm.

4. Reduce floodwater and sediment damage to roads, highways, and appurtenant drainage structures.

5. Improve internal drainage of cropland soils.

6. Improve fish and wildlife resources.

7. Improve water quality by reducing sediment and other agricultural and urban pollutants.

## The Project In Brief

Project formulation, including land treatment and structural measures, was determined after considering the various alternatives that would meet the sponsors' objectives and be within the Soil Conservation Service standards and policies.

The project selected consists of land treatment measures supplemented by two floodwater retarding structures and an outlet structure for Long Lake.

## Environmental Considerations

Environmental impacts of the proposed project measures were analyzed. The impact of proposed land treatment measures are

predominantly favorable. Reduced erosion and sedimentation, increased soil moisture, improved wildlife habitat, and increased crop production are all favorable effects resulting from land treatment.

Environmental impacts of the proposed structural measures were mostly favorable, but some adverse effects were determined. Particular attention was devoted toward features of the plan that would eliminate or minimize the adverse impacts.

Health and water quality were considered by specifying maintenance of a positive gradient through the dry sediment pool. Wetlands will be preserved. Structures were located so that displacement of people, businessess, and farm operations would be minimized.

Stream sedimentation during construction will be minimized by the use of sediment basins and immediate revegetation of denuded areas.

Reduction in flood peaks, sedimentation, erosion, and downstream damages are all favorable effects resulting from the two floodwater retarding structures and the Long Lake structure.

## Alternatives

Various combinations of structural and nonstructural measures were considered, including those suggested by interested agencies, groups, and individuals. The more significant alternatives considered to solve the water and related land resource problems were:

1. Continuation of the present trends.

2. Accelerated land treatment only.

3. Accelerated land treatment, flood plain zoning, and floodproofing of existing buildings subject to flood damage.

4. Accelerated land treatment, flood plain zoning, and flood plain evacuation.

5. Accelerated land treatment, flood plain zoning, one floodwater retarding structure, Long Lake outlet structure, and construction of a bypass channel to divert Spring Creek around Brillion.

6. Accelerated land treatment, flood plain zoning, two floodwater retarding structures, Long Lake outlet structure, and channel work on Spring Creek.

7. Accelerated land treatment, flood plain zoning, two floodwater retarding structures; Long Lake outlet structure, and a multiple-purpose flood control and agricultural water management channel.

Continuation of the present trends in the use of the watershed will result in part of the land treatment being installed. Some reduction in erosion and sediment damage can be expected, but there will be no measurable reduction in floodwater damages. If the project is not installed, an estimated $32,265 of net average annual benefits would be foregone. This is the estimated average annual benefits, $52,120, less the estimated average annual cost of the proposed project, $19,855.

Eliminating all structural measures from the plan and installing only the planned conservation land treatment would have the same beneficial effect in the upland areas, but floodwater damages would be reduced by less than one percent. This alternative would leave Brillion and the Long Lake residents with a continuing threat of flooding.

Consideration was given to a nonstructural program of zoning flood prone areas allowing only compatible use. About 30 acres of the flood-prone area has extensive development. Most of the homes and many of the businesses, notably the Brillion Iron Works, are not readily adaptable to floodproofing. Floodproofing existing buildings would cost in excess of $3 million. The level of protection would be low.

A change from urban to less intensive use, such as flood plain zoning and moving the homes and businesses out of the flood plain, would eliminate most of the flood damage potential. The cost of relocating 89 homes and 18 businesses would exceed $30 million.

Installation of conservation land treatment systems supplemented by flood plain zoning, a floodwater retarding structure, an outlet structure for Long Lake, and a bypass channel or floodway to divert Spring Creek flood flows around Brillion would meet the sponsor's objectives. Structural works will reduce floodwater and sediment damages by about 99 percent in Brillion and the Long Lake summer home area. Installation of these structural

measures would affect approximately 60 acres of cropland, 53 acres of grassland, and 2 acres of forest land, along with the associated upland game habitat. The estimated cost of installing this combination of structural measures is $1,065,200.

Installation of conservation land treatment systems supplemented by flood plain zoning, two floodwater retarding structures, an outlet structure for Long Lake, and channel work on Spring Creek would reduce urban flood damages. No outlet would be provided for surface and subsurface drainage of croplands. The Long Lake outlet structure, the land treatment, and urban flood damage reduction will remain the same. This proposal would require that one bank of Spring Creek within Brillion be disturbed. Several large trees would be removed. Several bridges would be enlarged or replaced. Construction of the channel work would be annoying to nearby residents because of the noise and dust. Installation of these structural measures would affect approximately 120 acres of cropland, 86 acres of grassland, and 14 acres of forest land along with the associated upland game habitat. The estimated cost of installing this combination of structural measures is $560,000.

Installation of conservation land treatment systems supplemented by flood plain zoning, two floodwater retarding structures, an outlet structure for Long Lake, and a multiple-purpose flood control and agricultural water management channel would best meet the sponsor's original objectives. The land treatment, Long Lake outlet, and urban floodwater damage reduction will remain the same. The multiple-purpose channel will be located where no channel now exists. It will provide a drainage outlet for 850 acres of cropland, reduce flood damages on an additional 200 acres of farmland, and protect the proposed industrial park on the west side of Brillion. This channel would require the installation of new bridges at U.S. Highway 10, Chicago and Northwestern Railroad and Center Street. The installation of these structural measures will affect approximately 140 acres of cropland, 90 acres of grassland, and 8 acres of forest land. The estimated cost of installing this combination of structural measures is $835,000.

Alternate No. 7 would best meet the sponsor's original objectives of watershed protection, flood prevention, and drainage. The benefit-cost ratio is 2.1:1. Alternate No. 6, with a cost-benefit ratio of 2.3:1, solves the watershed protection and flood prevention objectives, but the drainage problem remains. The remaining alternates are either very expensive or do not solve the watershed problems. Local

citizens, at a public meeting in Brillion on January 19, 1973, considered the various alternatives and selected the planned works of improvement as the best means of meeting their current objectives at a reasonable cost.

## WORKS OF IMPROVEMENT TO BE INSTALLED

### Land Treatment Measures

Resource conservation plans developed for the operating units of the watershed and implemented on an individual land unit will provide for the proper use and management of the land.

A combination of land treatment measures will be applied by individual farm operators or owners for the purpose of soil and water conservation, particularly in the upland areas. In order to adequately protect the watershed, the Calumet and Manitowoc County Soil and Water Conservation District programs will continue to stress the application and maintenance of conservation practices. This includes the management and use of land within its capabilities and treatment in accordance with its needs.

Soil surveys in the Brillion watershed have been completed. Soil survey information is expected to be published in an interim soil survey report by June 1975.

An accelerated program of land treatment measures is planned during the 4-year project installation period. Thirty-three percent of the upland area will be adequately treated during this period.

Approximately 2,060 acres of cropland, 1,020 acres of grassland, 543 acres of other land, and 637 acres of forest land are now adequately protected. Within the 4-year project period, an additional 3,000 acres of cropland, 200 acres of grassland, 700 acres of other land, and 726 acres of forest land will be treated.

Amounts of land treatment measures to be applied during the 4-year project installation period were determined by the district supervisors and the directors of the watershed association based on recommendations of the Soil Conservation Service, U.S. Forest Service, and the Wisconsin Department of Natural Resources.

Land treatment measures to be applied on cropland, grassland, forest land, and other land (building sites, roads, etc.) include; conservation cropping systems, contour farming, diversions, drainage field ditches, stabilization structures, grassed waterways and outlets, ponds, streambank protection, stripcropping, subsurface drain, terracing, tree planting, wildlife wetland and upland habitat management, and woodland improvement.

A conservation cropping system is growing crops in combination with needed cultural and management measures. Cropping systems include rotations that contain grasses and legumes as well as rotations in which the desired effects are achieved without the use of such crops. Conservation cropping systems reduce soil losses and thus improve water quality, enhance natural beauty, and improve fish and wildlife habitat.

Contour farming is farming sloping cultivated land in such a way that plowing, preparing land, planting, and cultivating are done on the contour. This includes following established grades of terraces or diversions.

A diversion is a channel with a supporting ridge on the lower side constructed across the slope. It is designed to carry runoff to an area with a suitable outlet. Diversions are frequently used to provide protection to farm buildings and other developments.

A drainage field ditch is a graded ditch for collecting excess water within a field.

Grade stabilization structures are used to stabilize the channel grade and to control erosion (head cutting) in natural or artificial watercourses. They prevent the advance of gullies and improve fish and wildlife habitat by reducing sedimentation and by making conditions more favorable for establishing vegetation.

A grassed waterway or outlet is a natural or constructed waterway or outlet shaped or graded and established in suitable vegetation as needed for the safe disposal of runoff from a field, diversion, terrace, or other structure. Grassed waterways along with other conservation practices prevent or heal gullies. They can provide field edge for year-round use by wildlife. Properly maintained waterways make good nesting sites for ground nesting birds.

A pond is a water impoundment made by constructing a dam or embankment, or by excavating a pit or dugout. It creates fish and wildlife habitat in the form of open water or wetlands.

Streambank protection is stabilizing and protecting banks of streams or excavated channels against scour and erosion by vegetative or structural means. This improves fish and wildlife habitat by reducing sedimentation and by establishing vegetation on channel banks. Natural beauty is also enhanced.

Stripcropping is growing crops in a systematic arrangement of strips or bands on the contour or across the general slope to reduce water erosion. The crops are arranged so that a strip of grass or close-growing crop is alternated with a strip of clean-tilled crop or fallow, or a strip of grass is alternated with a close-growing crop. Runoff is slowed down and reduced by stripcropping.

A subsurface drain is a conduit, such as tile, pipe, or tubing, installed beneath the ground surface to collect and convey drainage water.

A terrace is an earth embankment or a ridge and channel constructed across the slope at a suitable spacing. It has no grade (level terrace) or an acceptable grade (gradient terrace). Terraces carry water to a grassed waterway or other suitable outlet for safe disposal. Terracing breaks up long slopes into shorter slopes. It reduces erosion and increases infiltration of water into the soil.

Tree planting is planting tree seedlings or cuttings. Forest land protected from grazing and burning soaks up more rainfall and produces less erosion.

Wildlife habitat improvement and management is retaining, creating, or managing wildlife habitat. The habitat may be upland or wetland habitat.

Woodland improvement is removing unmerchantable or unwanted trees, shrubs, or vines from woodland.

A typical combination of practices on sloping cropland fields will be contour stripcropping, conservation cropping systems, terraces, and grassed waterways. On gentle slopes alternatives to contour stripcropping are the use of terraces with contour farming.

The land treatment measures are based on present and projected land uses. If the future land use differs appreciably from that expected, alternative land treatment measures that will accomplish the same purposes will be installed. These changes, if necessary, will be made during project installation and will become a part of the county soil and water conservation district long-range program.

Table 1 shows the estimated cost of land treatment measures to be installed within the 4-year installation period of the project. The total cost of installing these measures, including the cost of technical assistance, is estimated at $213,560. The status of land treatment applied to date is shown in table 1A.

## Structural Measures

Structural measures are needed in addition to land treatment measures to reduce flood peaks on residential, industrial, and other lands adjacent to Spring Creek and its tributaries. The proposed structural measures consist of two floodwater retarding structures and a water level control structure. Structural data are shown in tables 3, 3A, and 3B. The location of these measures is shown on figure 6 - Project Map. Structural details are shown on figures 1, 2, and 3.

The two floodwater retarding sites (FRS) are located above Brillion. FRS No. 1 is located in the northeast quarter of section 23, 20 N., R. 20 E. FRS No. 2 is located in the northwest quarter of section 25, T. 20 N., R. 20 E. The two structures will consist of earthfill dams with reinforced concrete pressure pipe principal spillways and vegetated earth emergency spillways.

FRS No. 1 will have a maximum height of about 19 feet and a length of 840 feet. The centerline is located across a relatively narrow gap of Spring Creek with somewhat concave valley sides. The dam is supplemented by a 2,640-foot long saddle dike on the west side.

FRS No. 2 will have a maximum height of about 17 feet and a length of 800 feet. The site is located at a broad flared gap on an unnamed intermittent stream. The slopes are hayland.

*THE CENTERLINE OF FLOODWATER RETARDING SITE NO 1 IS LOCATED 270 FEET UPSTREAM (LEFT) OF HACKER ROAD*

*THE LONE TREE IS ON THE CENTERLINE OF FLOODWATER RETARDING STRUCTURE NO. 2.*



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The embankments and principal spillways for FRS No. 1 and No. 2 will be on foundations classified as yielding. Slight consolidation is expected. There are no rock outcrops in the vicinity of the centerlines.

At FRS No. 2 about 60 feet of land on the right side of the stream is underlain by a combination of silt, clay, and peat with low bearing capacity. This material will be removed and replaced.

An ample supply of good quality low plastic clay fill material is available for the embankments. The borrow areas are on ground moraine of the Valders till sheet of the Wisconsin Stage of Pleistocene glaciation.

Borrow for embankment fill for FRS No. 1 will be taken from areas adjacent to both abutments upstream from the centerline. Most of the borrow material for FRS No. 2 will be taken from the emergency spillway. The remainder will be taken from the abutment area downstream from the emergency spillway.

Borrow depths will be limited to avoid the highly dispersed materials of the underlying Cary till. Borrow areas will be revegetated. Bedrock should not be encountered.

Most of the borrow will be within the area required for the structure and flood pool. Additional land rights will be needed for the remainder of the borrow.

The principal spillways and retarding storage will control the runoff resulting from a flood occurring on the average of once in 100 years (100-year flood). The principal spillways will be 30-inch diameter reinforced concrete pressure pipe outlets. FRS Nos. 1 and 2 have modified single-stage risers. See figure 1 for details. The outlets of the conduits will be cantilever beams with pipe supports. Energy from flows will be dissipated in plunge pools. The modified inlet will permit the structures to be operated with a dry or wet sediment pool for wildlife (waterfowl) purposes. Both structures will be designed for wet sediment pool conditions. FRS No. 1 will have a wet sediment pool. No recreational facilities are planned for this shallow sediment pool. Public use will be allowed. Some incidental recreation such as hunting may occur. Public access to the wet pool is available at Harvestore and Hacker Roads. Sanitary facilities will be provided as required by State and local health agencies. The dry sediment pool of FRS No. 2 will provide additional flood retarding storage until gradually displaced over the design life by sediment. Negligible or no recreational opportunities exist at this site.

The sediment pool is an area allocated to the storage of sediment expected to be deposited throughout the design life of the structure (100 years). Initially, this sediment pool area may be used to store water by closing a water control gate. By opening the gate, the water will flow through a bottom release pipe. This design allows the sediment pool to be operated either wet (gate closed) or dry (gate open).

Both structures have a design life of 100 years. FRS No. 1 will contain 0.63 watershed inches or 110 acre-feet of accumulated sediment. FRS No. 2 will contain 0.48 watershed inches or 34 acre-feet of accumulated sediment. The sediment pool areas will be 48 and 17 acres, respectively.

The emergency spillways will be excavated vegetated earth spillways. The bottom widths at the control section will be 400 feet for FRS No. 1 and 240 feet for FRS No. 2.

The floodwater storage capacity of 539 acre-feet for FRS No. 1 is equivalent to 3.10 watershed inches. The floodwater storage capacity of 186 acre-feet for FRS No. 2 is equivalent to 2.60 watershed inches. The flood pool areas are 140 acres and 33 acres, respectively.

Approximately 73 percent of the watershed area is controlled above Water Street by the combination of FRS No. 1 and FRS No. 2. Water Street is approximately the center of the watershed area subject to damage. FRS No. 1 provides 66 percent of this control and FRS No. 2 provides the remaining 34 percent. The drainage area above FRS No. 1 is 3.26 square miles and the drainage area above FRS No. 2 is 1.34 square miles.

The construction and operation of the two structures will affect two town roads and U.S. Highway 10. FRS No. 1 will require 1,360 feet of Hacker Road to be changed below the emergency spillway. In addition, about 360 feet of Harvestore Road would be subject to flooding from the 100-year flood and will be raised. U.S. Highway 10 crosses the FRS No. 2 flood pool. Under present and future conditions U.S. Highway 10 at this location is inundated to a maximum depth of 1.5 feet during the 100-year flood. It is planned to raise the highway above the 100-year flood line.

Construction of FRS No. 1 will require moving or modifying 1,360 feet of 4-inch gas line owned by the Wisconsin Public Service Corporation. Construction of FRS No. 2 will require moving

or modifying about 1,100 feet of a 4-inch and 300 feet of a 6-inch gas line owned by the Wisconsin Public Service Corporation. The line crosses the sediment and flood pools.

Land rights for the structures, spillways, pool areas, and work areas will require 157 acres for FRS No. 1 and 72 acres for FRS No. 2.

The structure located at the outlet of Long Lake will be a reinforced concrete straight drop spillway with an earthen emergency spillway. It will pass the 100-year storm with a 1-foot rise in the level of Long Lake. The structure will have a 50-foot weir length, 1.5-foot weir depth, and 3-foot overfall. The crest elevation will be approximately 3 inches lower than present lake level. About 2,600 feet of channel work beginning 200 feet upstream is needed for proper operation of the structure. The work consists of shaping the intermittent stream to a 50-foot bottom and 3:1 sideslopes. The bottom profile will be excavated to match the crest and apron of the drop spillway. The spoil will be levelled and seeded. Seven acres are required for land rights and work areas. One farm road crossing will need to be modified. See figure 6 for location.

*LONG LAKE OUTLET CHANNEL.*
*THE STRUCTURE SITE IS BEHIND THE HILL ON THE LEFT.*

Measures to be taken during construction to minimize soil erosion and water, air, and noise pollution are those described in the Soil Conservation Service Engineering Memorandum 66, Guidelines for Minimizing Soil Erosion and Water and Air Pollution During Construction; Soil Conservation Service Engineering Memorandum 76, Public Safety at Structural Works of Improvement; and the U.S. Department of the Interior, Bureau of Reclamation publication, Safety and Health Regulations for Construction. Contractors will be required to adhere to strict guidelines for minimizing soil erosion and water and air pollution during construction. Construction areas will be vegetated during and immediately after construction. Measures such as diversions, debris basins, and stream crossings will be installed as needed to control pollution.

Based on a thorough onsite investigation by the State Historical Society, no historical or archeological sites are in or near the proposed works of improvement. However, the State Historical Society of Wisconsin and the National Park Service will be advised if evidence of archeological impact is discovered during construction.

Investigation has disclosed that under present conditions the project measures will not result in the displacement of any person, business, or farm operation.

## Nonstructural Measures

The city of Brillion in cooperation with the Wisconsin Department of Natural Resources will adopt a flood plain ordinance prior to construction of the structural measures. The ordinance will be in accordance with State laws. The Calumet County Soil and Water Conservation District has petitioned the county to adopt flood plain zoning for the watershed based on data developed for this work plan.

## EXPLANATION OF INSTALLATION COSTS

Project installation costs are given in tables 1 and 2. The total estimated cost is $537,970, of which $213,560 is the cost of establishing land treatment on private land and $324,410 is the cost of structural measures.

### Land Treatment Measures

The estimated cost of land treatment measures is $198,640 for cropland, grassland, and other land measures, and $14,920 for forest land measures. The cost of establishing the land treatment measures includes the cost of applying the measures and the cost of technical assistance.

The estimated costs of establishing land treatment measures were based on the current costs for rental of contract equipment, labor, supervision, and materials. Costs of applying land treatment measures will be borne by individual landowners and operators.

Cost of technical assistance was based on similar costs for existing conservation programs in this area. Technical assistance from regular appropriations of the Soil Conservation Service and that needed under an accelerated program will be used to accomplish project objectives. Through cooperative agreements with the Forest Service, technical assistance will be provided by the Wisconsin Department of Natural Resources for forest land treatment measures. The cost of the technical assistance for accelerating the application rate of the land treatment measures will be met by Public Law 566 funds. The technical assistance item includes salaries and associated costs of technicians who will assist the owners and operators in applying the measures. Following is a table showing the Public Law 566 and other fund obligation by years during the installation period. Other costs include technical assistance and application.

EXPECTED EXPENDITURES FOR LAND TREATMENT
(DOLLARS)

| Year | Cropland, Grassland, and Other Land | | | Forest Land | | |
|---|---|---|---|---|---|---|
| | Public Law 566 | Other | Total | Public Law 566 | Other | Total |
| 1 | 7,650 | 32,100 | 39,750 | 0 | 3,000 | 3,000 |
| 2 | 11,500 | 48,100 | 59,600 | 0 | 4,500 | 4,500 |
| 3 | 13,400 | 56,100 | 69,500 | 0 | 5,200 | 5,200 |
| 4 | 5,670 | 24,120 | 29,790 | 0 | 2,220 | 2,220 |
| TOTAL | 38,220 | 160,420 | 198,640 | 0 | 14,920 | 14,920 |

Structural Measures

The total installation cost for structural measures includes cost of construction, engineering services, land rights, relocation payments, and project administration. These installation costs are shown in tables 1 and 2.

The construction costs in the engineer's estimate were based on recent contract data for Public Law 566 projects in Wisconsin. The total construction cost includes contingencies of ten percent.

The cost of engineering services includes services of engineers, hydrologists, and geologists for surveys, site investigations, soil mechanics, structural designs, flood routing, and construction plans and specifications. Engineering costs are estimated at 10 to 12 percent of the construction cost.

Land rights costs were determined through meetings with the sponsoring local organization and concurred in by the Soil Conservation Service. Land rights include cost for land acquisition, easements, rights-of-way, and modification of utilities, roads, and other improvements. Included are elements of work involving construction and engineering services directly associated with land rights. Land rights costs are estimated at $105,700. Cost for land acquisition, easements, and rights-of-way is estimated to be $52,800. However, this does not preclude the possibility of the purchase or donation of flowage easements in lieu of direct land purchases. Moving or modifying utilities include $28,900 for a gas line and $2,450 for seven power poles. Road modifications include $4,400 for U.S. Highways, $13,800 for two town roads, and $1,850 for a farm crossing. A farm building will be moved at an estimated cost of $1,500.

Relocation payments include moving and related expenses for a displaced person, business, or farm operation, as well as financial assistance for replacement housing for a displaced person who qualifies and whose dwelling is acquired because of the project. There are no relocation payments involved in this project.

The costs of project administration are the Public Law 566 and other administration costs associated with the installation of structural measures. This includes costs for contract administration, relocation assistance advisory services, review of engineering plans prepared by others, government representatives, construction layout, and necessary inspection service during construction to insure that structural measures are installed in accordance with the plans and specifications. Project administration costs for Public Law 566 and other funds are estimated at 15 to 25 percent and 2 percent of the construction cost, respectively. No relocation assistance advisory services are anticipated because there are no relocations involved in this project. If needed, these services will be provided by the sponsors.

The expected expenditures of funds by fiscal years for the installation of structural measures during the 4-year period is shown on the following table.

## Public Law 566 Funds

The following will be borne by Public Law 566 funds:

1. The cost of technical assistance needed to accelerate the application of land treatment measures (Estimated cost $38,220).

2. The construction cost of the structural measures for flood prevention (Estimated cost $161,020).

3. The cost of the engineering services for all structural measures (Estimated cost $18,490).

4. Project administration costs incurred by the Federal government (Estimated cost $36,000).

## Other Funds

The following will be borne by other funds:

1. The cost of installing land treatment measures (Estimated cost $166,720).

2. Cost of technical assistance for the existing land treatment program (Estimated cost $8,620).

3. Project administration cost incurred by the sponsors (Estimated cost $3,200).

4. Total cost of land rights for the structural measures (Estimated cost $105,700).

## EFFECTS OF WORKS OF IMPROVEMENT

### Flood Prevention, Erosion, and Sediment

Land treatment measures on the uplands will reduce average cropland sheet and gully erosion from 3.1 to 2.8 tons per acre per year. Water retention capability of upland areas will be increased, resulting in an overall reduction in surface runoff volume. Land treatment measures to be installed by individual farmowners and operators will have the following effects:

1. All types of erosion will be reduced. It is estimated that land treatment measures to be installed during the 4-year installation period will reduce cropland sheet and gully erosion by 0.3 tons per acre per year. This is a decrease of ten percent. A similar decrease will occur for other agricultural land uses.

2. Damage from sedimentation will be reduced. Reduction in erosion will be accompanied by a corresponding reduction in sedimentation. This sediment reduction will be supplemented by the trap efficiency of the two floodwater retarding structures. It is estimated that sediment reaching the Brillion Marsh from the watershed will be reduced by 37.5 percent of the present estimated delivery rate of 7,200 tons per year.

3. Soil moisture and ground water recharge will be increased through improved hydrologic characteristics. Water retention (precipitation minus runoff) will be increased.

4. Productive land, a prime national resource, can be used more wisely and within its capability.

5. Installation of forest land treatment measures and intensified multiple-use management will enhance recreational and wildlife values and contribute substantially to beautification, esthetic appeal, environmental quality, and future use of the woodland resources.

6. Costs of maintaining structural works of improvement will be reduced by the installation of land treatment measures above structure sites.

-Effects-

7. Wildlife habitat will be protected and enhanced.

8. Runoff will be reduced by about one percent in downstream areas.

9. About 150 acres of wet cropland will be drained. Average yields on this land will increase by the following percentages: corn, 73; oats, 38; and hay, 77.

Proposed land treatment measures to be installed during the project period will affect approximately 3,900 acres of cropland or grassland and 726 acres of forest land. The total acreage affected, 4,626, is about 33 percent of the 13,811 acres in the Brillion watershed.

Structural works of improvement to supplement the land treatment measures will protect 660 of the 1,540 flood plain acres in the watershed. Structural measures will reduce floodwater and sediment damage by amounts ranging from a minimum of 47 percent to a maximum of 100 percent in the affected area.

The two floodwater retarding structures will control 21 percent of the watershed and about 73 percent of the total drainage above Water Street in Brillion. The depth of flooding and the area flooded will be reduced on approximately 120 acres of agricultural land and 103 acres of urban land. Reductions in area flooded around Long Lake and below the floodwater retarding structures for 24-hour duration storms are shown in the following table.

Area Flooded In Acres

| Storm | Without Project | With Project |
|---|---|---|
| 2-year | 360 | 230 |
| 5-year | 480 | 310 |
| 10-year | 540 | 350 |
| 100-year | 660 | 470 |

The total area where flooding by the 100-year frequency storm is eliminated by structural measures is estimated to be 190 acres. Flooding is reduced on an additional 470 acres.

Typical reductions in peak flows for 24-hour duration storms of 100-year and 5-year frequencies for selected locations within the watershed are:

PEAK DISCHARGES IN CUBIC FEET PER SECOND

| Location | 100-year | | 5-year | |
|---|---|---|---|---|
| | Without | With | Without | With |
| U.S. Highway 10 | 1,790 | 75 | 750 | 55 |
| Water Street | 2,310 | 1,190 | 970 | 500 |
| Sunset Drive | 2,320 | 1,350 | 960 | 600 |

Within Brillion the following minimum levels of protection will be obtained: (1) 100-year frequency flood or better protection at U.S. Highway 10; (2) 100-year frequency flood protection or better

at Water Street; (3) 2-year frequency flood protection at Sunset Drive. The above levels of protection are minimums. Urban property in Brillion, except for some yards, gardens, streets, and the park, will have 100-year protection. Some houses are in the 100-year flood plain; however, no first floor damage will occur. The cabins and trailers along Long Lake will have 100-year protection.

Typical reduction in stage from floods of 100-year frequency would be 6 feet in the agricultural area above Brillion. The reduction in stage would be about 1 foot in the residential and agricultural areas of the downstream portion of the watershed. The level of Long Lake will have a stage reduction of 3 feet.

Structural flood prevention measures will protect 38 homes, 18 commercial buildings, 3 agricultural landowners, and 10 bridges. Fifty-one properties with either temporary or permanent residences will receive protection from the Long Lake structure. About 103 acres are subject to flooding in Brillion from a 100-year flood event. The effects of structural measures would be to reduce the area flooded to about 80 acres. The degree of protection is illustrated on figures 4 and 5. The future 100-year flood (with project) will be equivalent to the present 10-year flood.

The flood stage resulting from a storm of the size of the 1969 flood would be reduced 2 feet at Water Street. The flood stage at the Brillion Iron Works plant would be reduced 3 feet and the flood stage in the upland agricultural area would be reduced about 4 feet.

Remaining flood hazard will exist on the flood plain for large, infrequent storms. See the dark blue area in figure 4. In lower agricultural areas and in the Brillion Marsh area infrequent flooding will continue but the extent and depth of floods will be reduced.

Present land use in the flood plain of Spring Creek is expected to continue. Major agricultural lands in the Spring Creek flood plain (about 40 acres) will be provided with a more stable productivity. Increased agricultural production on new lands is not a primary purpose of this project. Benefits derived from increased production from surplus crops on new lands are not necessary for economic justification.

Installation of FRS No. 2 will affect any future relocation of U.S. Highway 10. No rerouting is currently being considered.

Project installation will reduce floodwater damages in the protected area by 51 percent in agricultural areas and by 99 percent in non-agricultural areas ($49,250 to $1,400).

## Fish and Wildlife and Recreation

About 1.5 miles of intermittent streams will be inundated by the sediment pool at FRS No. 1 and 0.5 miles of intermittent stream will be in the dry sediment pool of FRS No. 2. An additional 250 feet of stream will be replaced by pipe flow through the dams. FRS No. 1 will release warmer water affecting 1 mile of Spring Creek between the dam and Brillion Iron Works. This discharge should be intermittent, since the present stream is intermittent at the structure site.

The Long Lake structure and its approach and exit channels will disrupt about 0.5 miles of intermittent stream and its associated types 2 and 3 wetlands.

The dams and spillways at FRS No. 1 and FRS No. 2 will destroy an estimated 2 and 6 acres of wetlands, respectively. Approximately 35 acres of wetlands will be inundated by the wet sediment pool at FRS No. 1. The dry sediment pool at FRS No. 2 contains 10 acres of wetlands. After the project there will be 48 acres of wetlands at FRS No. 1 and 17 acres of wetlands at FRS No. 2 for an overall gain of 12 acres of wetlands. Most of the above wetlands are types 2, 3, 4, and 5 (8).

The project will create a 48-acre sediment pool with a shoreline of 1.9 miles at FRS No. 1. This pool has a design life of 100 years. It will fill with accumulated sediment and eventually become a marsh. Meanwhile, it will be used by waterfowl as a satellite pool to the larger development planned by the Wisconsin Department of Natural Resources. It will provide hunting opportunities. Public access is available at Harvestore Road and Hacker Road. FRS No. 2 will provide negligible or no recreational opportunities.

The new structure at Long Lake will lower the water elevation about 0.3 feet. This will result in a slightly smaller lake area. The lake level will be stabilized, resulting in less fluctuating of the lake throughout the year. The benthic community will not be subjected to fluctuating water levels.

Land treatment and structural measures will reduce sediment in the streams by about 2,600 tons per year, resulting in improved fish habitat.

-Effects-

The two floodwater retarding structures and the Long Lake structure will affect 122 acres of cropland, 80 acres of grassland, 8 acres of forest land, and 11 acres of other land. After completion of the project there will be 48 acres of water, 44 acres of cropland, 125 acres of grassland, no forest land, and 4 acres of other land. The acres of each land use for each structure for present conditions and with project are:

| Str. | Land Use | Dam and Spillway | | Sediment Pool | | Flood Pool | | Total | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1/ | 2/ | 1/ | 2/ | 1/ | 2/ | 1/ | 2/ |
| 1 | Cropland | 10 | 0 | 20 | 0 | 72 | 42 | 102 | 42 |
| | Grassland | 1 | 12 | 16 | 0 | 20 | 50 | 37 | 62 |
| | Forest Land | 0 | 0 | 8 | 0 | 0 | 0 | 8 | 0 |
| | Other Land | 1 | 0 | 4 | 48 3/ | 2 | 2 | 7 | 50 3/ |
| | Total | 12 | 12 | 48 | 48 | 94 | 94 | 154 | 154 |
| 2 | Cropland | 3 | 0 | 0 | 0 | 15 | 0 | 18 | 0 |
| | Grassland | 3 | 6 | 15 | 17 | 20 | 35 | 38 | 58 |
| | Forest Land | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Other Land | 0 | 0 | 2 | 0 | 2 | 2 | 4 | 2 |
| | Total | 6 | 6 | 17 | 17 | 37 | 37 | 60 | 60 |
| Long Lake | Cropland | 2 | 2 | 0 | 0 | 0 | 0 | 2 | 2 |
| | Grassland | 5 | 5 | 0 | 0 | 0 | 0 | 5 | 5 |
| | Forest Land | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Other Land | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total | 7 | 7 | 0 | 0 | 0 | 0 | 7 | 7 |
| Total | Cropland | 15 | 2 | 20 | 0 | 87 | 42 | 122 | 44 |
| | Grassland | 9 | 23 | 31 | 17 | 40 | 85 | 80 | 125 |
| | Forest Land | 0 | 0 | 8 | 0 | 0 | 0 | 8 | 0 |
| | Other Land | 1 | 0 | 6 | 48 3/ | 4 | 4 | 11 | 52 3/ |
| | Total | 25 | 25 | 65 | 65 | 131 | 131 | 221 | 221 |

1/ Present conditions
2/ With project
3/ Includes 48 acres of wet sediment pool.

The project will have a minimal affect on the availability of water and land resources to the potential users. Some intermittent streams and some wetlands will be lost. However, the 48-acre wet sediment pool will be available to the public.

No known rare or endangered species will be affected by the project.

## Archeological, Historical, and Scientific

Based on surveys conducted by qualified archeologists under the direction of the State Historic Preservation Officer, the Soil Conservation Service has determined that there will be no archeological sites effected by the project. It was also determined that the project would have no effect on historical or architectural properties either listed or eligible for listing in the National Register of Historic Places. (15) The lime kiln ruins in Brillion will not be affected.

Areas determined to be of scientific or natural area significance will not be affected by flood control structures or other construction as outlined in the work plan.

## Economic and Social

The quality of living in the flood prone areas of Brillion and Long Lake will improve with increased flood protection. Homeowners will make more improvements on their properties. Reduced flooding will result in less water-borne debris to be removed. The flood plain will be more usable for recreational activities, such as hiking, playing, or picnicking, because of less flooding and sediment and debris deposition. Traffic interruptions due to flooded streets will be minimized. The threat of death by drowning in floodwater in Spring Creek will be reduced. Overall, residents will feel more secure in their day-to-day activities.

The 221 acres required for the structural measures will be maintained as open spaces. The 48-acre sediment pool at FRS No. 1 will have public access.

## General

Land required for structural measures for the project is 221 acres. In general, habitat losses are balanced by gains for waterfowl and other wildlife and game. Also, man's environment will be improved by the reduction of flooding.

## PROJECT BENEFITS

Project works of improvement, including land treatment and structural measures, will reduce estimated average annual direct and indirect floodwater damages within the benefited area of the watershed from $49,250 to $1,400. This is a reduction of 97 percent (table 5).

Direct average annual primary benefits accruing from the reduction of floodwater damage to cropland and pasture are estimated at $660. Benefits from a reduction in damages to residential and commercial areas are expected to be $40,980.

Estimated direct annual benefits from the reduction of floodwater damages to roads and bridges are $1,520.

Sediment reduction benefits within the watershed are estimated at $230.

Indirect benefits are estimated at $4,460 annually. These benefits were estimated at 10 percent of total agricultural direct benefits, 15 percent of urban benefits, and 20 percent of road and bridge benefits.

The estimated direct and indirect floodwater damage reduction benefits within the watershed from project installation will total $47,850 annually. Of this amount, land treatment will provide $60 in damage reduction benefits.

Secondary benefits accruing from the project were estimated at $4,330 on an average annual basis. Secondary benefits from a national viewpoint were not considered pertinent to the economic evaluation.

Total flood prevention benefits accruing to project structural measures are estimated to be $52,120 annually.

## COMPARISON OF BENEFITS AND COSTS

The structural measures outlined in this plan are economically feasible. The average annual benefits to accrue as a result of the installation of the proposed structural measures are estimated to be $52,120. Average

annual benefits accruing to the project are $47,790 primary, and $4,330 secondary. The average annual cost of the proposed structural measures is estimated to be $19,885. The ratio of average annual benefits, including secondary benefits, to average annual cost is 2.6 to 1.0. The ratio of average annual benefits, without secondary benefits, to average annual cost is 2.4 to 1.0. Table 6 shows a comparison of annual benefits to annual costs.

## PROJECT INSTALLATION

Execution of this work plan will be a joint undertaking of nonfederal and Federal interests. Nonfederal interests include the Calumet County and the Manitowoc County Soil and Water Conservation Districts. Federal agencies involved with the project are the Forest Service and the Soil Conservation Service, of the U.S. Department of Agriculture.

In order to coordinate the installation of accelerated land treatment measures and structural measures provided for in this plan, close cooperation and specific responsibilities are required of private interests, the sponsors, and Federal agencies assisting with the project. The Calumet County and Manitowoc County Soil and Water Conservation Districts will have primary responsibility for accomplishing the plan. They will:

1. Provide technical assistance to landowners and operators in the watershed to assure the application of land treatment measures outlined in this plan.

2. Conduct an information and education program as needed to properly inform local people of the project.

3. Obtain cooperative agreements with individual farmers to install land treatment measures during the project period.

4. Carry out and assume the responsibility and all liability for the construction, operation, and maintenance of structural measures.

5. Acquire all land rights needed in connection with the works of improvement. The power of eminent domain will be exercised if necessary. The power of eminent domain for purposes of flood prevention and recreation is vested in county soil and water conservation districts under Section 92.08 (3), Wisconsin Statutes.

6. Comply with the real propery acquisition policies and regulations contained in the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970.

7. Act as contracting organization for the construction of all structural measures. Contracts for flood retarding structures No. 1 and 2 will not be let until the flood plain ordinance for the city of Brillion is adopted.

8. Administer contracts for the structural works of improvement. In addition, they will be accountable for managing finances associated with installing those measures which involve the expenditure of Public Law 566 funds. This will require development of a financial management system which shall provide for the maintenance of appropriate records, reports, audits, and accounts needed to satisfy the requirements of OMB Circular A-102.

The Forest Service will:

1. Through a cooperative agreement with the Wisconsin Department of Natural Resources, Bureau of Forest Management, furnish technical assistance for forest land treatment measures to be installed by landowners.

The Soil Conservation Service will:

1. Furnish technical assistance through the Calumet County and Manitowoc County Soil and Water Conservation Districts to landowners for the application of the land treatment measures outlined in this work plan.

2. Furnish services for engineering surveys, design, land rights work map, construction plans and specifications of structural works of improvement, and inspection during construction.

3. Allot Public Law 566 construction funds in accordance with cost sharing and the installation schedule outlined in this plan or as may be revised by mutual consent. Allocations of funds will be in accordance with national priorities and availability at the time of installation.

4. Maintain liaison with the sponsors and State and Federal agencies involved so that the objectives outlined in this plan will be accomplished.

Construction of structural works of improvement will be accomplished by private contracts. All contracts will be awarded on the basis of competitive bid by qualified bidders.

Project agreements will be executed by the sponsors and the Soil Conservation Service for each contract unit of work. Prior to the execution of such an agreement, all land, easements, and rights-of-way will be obtained and properly recorded by the sponsoring local organization in their county.

A 4-year installation period is planned for the project. The land treatment measures will be applied throughout the installation period. The construction schedule is as follows:

First Construction Year: Obtain all land rights for FRS No. 1 and the Long Lake structure.

Second Construction Year: Construct FRS No. 1 and Long Lake structure and obtain all land rights for FRS No. 2 except power line change, road change, and building removal.

Third Construction Year: Construct FRS No. 2 and change power lines and road and remove farm building.

## FINANCING PROJECT INSTALLATION

The project installation costs allotted to Public Law 566 will be paid from funds appropriated under the authority of Public Law 566, 83d Congress, 68 Stat. 666, as amended. This work plan does not constitute a financial document for obligation of Federal and other funds. Financial or other assistance to be furnished by the Soil Conservation Service in carrying out the plan is contingent on the appropriation of funds for this purpose.

The costs of installing land treatment measures will be borne by the individual landowners or operators with such financial assistance as may be available from county, State, or Federal funds.

The Soil Conservation Service will continue to provide technical assistance for land treatment at the present rate under the ongoing program. Public Law 566 funds will be used to accelerate land treatment during the project installation period.

-Project Installation-

Forest land treatment measures will be installed with private and public funds. They will be implemented through the ongoing Cooperative Management Program. Technical assistance will be cost-shared between the Forest Service and the Wisconsin Department of Natural Resources.

The installation costs for structural measures not borne by Public Law 566 funds will be the responsibility of the Calumet County and Manitowoc County Soil and Water Conservation Districts. The districts have analyzed their financial needs in consideration of the scheduled works of improvement so that funds will be available when needed. The local sponsor's share of the installation cost referred to as land acquisition, easements, and rights-of-way will be negotiated for or acquired by eminent domain. Funds will be available to the districts by agreement from the following units of government:

City of Brillion - 80 percent

Calumet County - 7.5 percent

Manitowoc County - 2.5 percent

Town of Brillion - 2.5 percent

Town of Maple Grove - 2.5 percent

Town of Rantoul - 2.5 percent

Town of Rockland - 2.5 percent

The Calumet County and Manitowoc County Boards have provided funds on an annual basis to the county soil and water conservation districts for this project. The city, county, and town units of government can levy taxes. In addition, the Brillion Watershed Association may accept and provide to the districts cash or landrights donations on a tax deductible basis.

In accordance with OMB Circular A-102, the Calumet and Manitowoc County Soil and Water Conservation Districts will account to the Soil Conservation Service certain earned program income during the grant period. Program income may include, but not be limited to, income from service fees, useage, or rental fees for the sale of assets projected with Federal funds under a Service fund agreement. For this purpose the grant period shall extend from the effective date of the Service fund obligating agreement until the date on which the Soil Conservation Service formerly notifies the sponsors that the undertaking has been satisfactorily completed.

## PROVISIONS FOR OPERATION AND MAINTENANCE

### Land Treatment

Landowners and operators cooperating with the county soil and water conservation district will be responsible for the maintenance of land treatment measures installed on their land. Technical assistance will be available from the U.S. Soil Conservation Service and the Wisconsin Department of Natural Resources, Bureau of Forest Management, in cooperation with the U.S. Forest Service.

### Structural Measures

The Calumet County and Manitowoc County Soil and Water Conservation Districts will operate and maintain all structural works of improvement after they are installed. The districts have obtained commitments from the Calumet County and Manitowoc County Boards that the boards will furnish necessary funds for operation, maintenance, and replacement of all works of improvement installed under this plan in their respective counties. This commitment is in the form of a resolution passed by the county boards. The sponsoring local organization may enter into agreements with other entities to carry out the operation and maintenance activities.

The sponsoring local organization is responsible for the proper operation and maintenance, without cost to the Federal government, of works of improvement which are installed in part with Public Law 566 funds and for which there will be a continuing need for operation and maintenance. They are also responsible for obtaining all necessary permits.

The structural measures for flood prevention require no manual operation to achieve the level of flood protection outlined in this plan. The gated sediment pools may be operated wet or dry. Specific items necessary for the operation and maintenance of the structural works of improvement shall include, but are not limited to, the following:

1. Periodic maintenance will be required to insure proper functioning of the structural works.

2. All structures are to be maintained by making repairs or replacements as needed.

3. Obstructions, trash, and debris are to be removed from the principal spillway inlets, outlets, channel, and other structural works during and immediately after storm events.

4. Repairs to structures or structural features damaged by floods will be made promptly.

5. FRS No. 2 will be operated dry because of the gas line passing through the pool area.

6. A drainage gradient will be maintained through the dry sediment pool so that no stagnant pools are formed. This will eliminate potential health hazards and mosquito breeding areas.

7. Mowing of the structure sites, channel, and sediment pool will be restricted to prevent damage to nesting habitat; however, mowing will be often enough to maintain good grass cover. In addition, spot control of noxious weeds may be accomplished by mowing or spraying.

Estimated annual costs for operation and maintenance is $1,530. This includes $340 for single-purpose flood prevention structures and $1,190 for Long Lake outlet control structure.

For a period of 3 years following installation of each structural measure, the Chairman of the Soil and Water Conservation District Supervisors, President of the Brillion Watershed Association, Chairman of the Highway Committee of the County Board, and a representative of the Soil Conservation Service will make a joint annual inspection. Annual inspections following the third year will be made by the Chairman of the Soil and Water Conservation District Supervisors, President of the Brillion Watershed Association, and the Chairman of the Highway Committee of the County Board. A report will be sent to the designated Soil Conservation Service representative. Inspections, including a report, will also be made after floods or after the occurrence of any situation that might adversely affect the operation of any of the structural measures. Inspections will cover all portions of each structure, channel below, and the ponded area above. It will include the determination of vector breeding areas. Those areas caused by the project that might pose a public health threat or nuisance to the public will be eliminated.

The installation and operation and maintenance of the planned works of improvement must meet the requirements of the Wisconsin Department of Health and Social Services, the Manitowoc County Public Health Nursing Service, and the Calumet County Public Health Nurses Office.

Representatives of the Federal, State, and county governments shall have free access at all times to the structural works of improvement for official activities. All phases of operation and maintenance of these facilities shall comply with applicable local, State, and Federal regulations.

All operation and maintenance agreements must be executed prior to the signing of the land rights agreement or the project agreement for construction of structural measures. A separate operation and maintenance agreement will be prepared for each structural measure. These agreements will contain, in addition to specific sponsor responsibilities for nonstructural and structural measures, specific provisions of OMB Circular A-102 for retention and disposal of real and personal property acquired in whole or in part with Public Law 566 funds.

Each operation and maintenance agreement will contain a reference to the State of Wisconsin Watershed Operation and Maintenance Handbook for Projects Installed With Assistance from the Soil Conservation Service. An operation and maintenance plan will be prepared for each structural measure.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST
BRILLION WATERSHED, WISCONSIN
(Dollars) 1/

| Installation Cost Item | Unit | Number 2/ Nonfederal | Public Law 566 Funds Nonfederal Land SCS 3/ | FS 3/ | Total | Other Nonfederal Land SCS 3/ | FS 3/ | Total | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| LAND TREATMENT | | | | | | | | | |
| Land Area 4/ | Acres | | | | | | | | |
| Cropland | to be | 3,000 | | | | 91,500 | | 91,500 | 91,500 |
| Grassland | Treated | 200 | | | | 25,000 | | 25,000 | 25,000 |
| Forest Land | | 726 | | | | | 11,400 | 11,400 | 11,400 |
| Other Land | | 700 | | | | 38,820 | | 38,820 | 38,820 |
| Technical Assistance | | | 38,220 | | 38,220 | 5,100 | 3,520 | 8,620 | 46,840 |
| TOTAL LAND TREATMENT | | | 38,220 | | 38,220 | 160,420 | 14,920 | 175,340 | 213,560 |
| STRUCTURAL MEASURES | | | | | | | | | |
| Construction | | | | | | | | | |
| Floodwater Retarding Structures | Each | 2 | 118,760 | | 118,760 | | | | 118,760 |
| Long Lake Outlet Structure | Each | 1 | 42,260 | | 42,260 | | | | 42,260 |
| Subtotal-Construction | | | 161,020 | | 161,020 | | | | 161,020 |
| Engineering Services | | | 18,490 | | 18,490 | | | | 18,490 |
| Project Administration | | | | | | | | | |
| Construction Inspection | | | 25,580 | | 25,580 | | | | 25,580 |
| Other | | | 10,420 | | 10,420 | 3,200 | | 3,200 | 13,620 |
| Subtotal-Administration | | | 36,000 | | 36,000 | 3,200 | | 3,200 | 39,200 |
| Other Costs | | | | | | | | | |
| Land Rights | | | | | | 105,700 | | 105,700 | 105,700 |
| TOTAL STRUCTURAL MEASURES | | | 215,510 | | 215,510 | 108,900 | | 108,900 | 324,410 |
| TOTAL PROJECT | | | 253,730 | | 253,730 | 269,320 | 14,920 | 284,240 | 537,970 |

1/ Price base - 1973

2/ No Federal land within the watershed

3/ Federal agency responsible for assisting in the installation of works of improvement

4/ Includes only areas estimated to be adequately treated during the project installation period. Treatment will be accelerated throughout the watershed. Dollar amounts apply to total land areas, not just to adequately treated areas.

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TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT
(As of March 31, 1973)
BRILLION WATERSHED, WISCONSIN

| Measures | Unit | Applied To Date | Total Cost Dollars 1/ |
|---|---|---|---|
| Land Treatment | | | |
| Conservation Cropping System | ac | 3,100 | 6,200 |
| Contour Farming | ac | 630 | 800 |
| Critical Area Planting | ac | 45 | 13,500 |
| Diversion | ft | 5,250 | 2,440 |
| Drainage Field Ditch | ft | 55,900 | 39,100 |
| Farm Animal Waste Management | ea | 1 | 4,000 |
| Farmstead and Field Windbreak | ac | 6 | 600 |
| Grassed Waterway or Outlet | ac | 50 | 6,000 |
| Subsurface Drain | ft | 74,000 | 29,600 |
| Wildlife Wetland Habitat Management | ac | 2,026 | 101,300 |
| Wildlife Upland Habitat Management | ac | 336 | 6,720 |
| Fire Control | ac | 850 | 0 2/ |
| Woodland Improvement | ac | 100 | 2,000 |
| Management Plans (5) | ac | 100 | 280 |
| Tree Planting | ac | 11.5 | 575 |
| Woodland Grazing Control | ac | 50 | 105 |
| TOTAL | | | 213,220 |

1/ Price base -- 1973

2/ Fire control paid by townships

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TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION
BRILLION WATERSHED, WISCONSIN

(Dollars) 1/

| Item | Installation Cost - Public Law 566 Funds | | | | Installation Cost - Other Funds | | | | Total Installation Cost |
|---|---|---|---|---|---|---|---|---|---|
| | Construction | Engineering | Land Rights | Total Public Law 566 | Construction | Engineering | Land Rights | Total Other | |
| Floodwater Retarding Structures 1 and 2 | 118,760 | 14,250 | | 133,010 | | | 102,450 3/ | 102,450 | 235,460 |
| Long Lake Outlet | | | | | | | | | |
| Control Structure | 20,700 | 2,140 | | 22,840 | | | 400 | 400 | 23,240 |
| Associated Channel(M) 2/ | 21,560 | 2,100 | | 23,660 | | | 2,850 4/ | 2,850 | 26,510 |
| Subtotal | 161,020 | 18,490 | | 179,510 | | | 105,700 | 105,700 | 285,210 |
| Project Administration | | | | 36,000 | | | | 3,200 | 39,200 |
| GRAND TOTAL | | | | 215,510 | | | | 108,900 | 324,410 |

1/ Price base - 1973

2/ Type of channel before project: (M) previously modified channel

3/ Includes $2,450 for moving power poles and $28,900 for moving and weighting - Wisconsin Public Service Gas Lines.

4/ Includes $1,850 for replacing a farm crossing.

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TABLE 3 - STRUCTURAL DATA
STRUCTURES WITH PLANNED STORAGE CAPACITY
BRILLION WATERSHED, WISCONSIN

| Item | Unit | Structure Number 1 | 2 | Total |
|---|---|---|---|---|
| Class of Structure | | c | c | |
| Drainage Area (Total) | sq mi | 3.26 | 1.34 | 4.60 |
| Curve No. (1-day) (AMC II) | | 78 | 78 | |
| Elevation Top of Dam | ft | 845.0 | 834.3 | |
| Elevation Crest Emergency Spillway | ft | 840.0 | 829.1 | |
| Elevation Crest High Stage Inlet | ft | 834.5 | 822.3 | |
| Maximum Height of Dam | ft | 19 | 17 | |
| Volume of Fill | cu yd | 38,800 | 26,300 | 65,100 |
| Total Capacity 1/ | ac-ft | 649 | 220 | 869 |
| Sediment Submerged | ac-ft | 91 | - | 91 |
| Sediment Aerated | ac-ft | 19 | 34 | 53 |
| Retarding | ac-ft | 539 | 186 | 725 |
| Surface Area | | | | |
| Sediment Pool | ac | 48 | (17) 2/ | 65 |
| Retarding Pool 1/ | ac | 140 | 33 | 173 |
| Principal Spillway Design | | | | |
| Runoff Volume (Areal) (1-day) | in | 2.84 | 2.84 | |
| Runoff Volume (10-day) | in | 7.1 | 7.1 | |
| Capacity of High Stage (Maximum) | cfs | 77 | 50 | |
| Frequency Operation-Emer. Spillway | % chance | 1 | 1 | |
| Dimensions of Conduit | in | 30 | 30 | |
| Emergency Spillway Design | | | | |
| Rainfall Volume (ESH) (Areal) | in | 9.02 | 9.02 | |
| Runoff Volume (ESH) | in | 6.34 | 6.34 | |
| Storm Duration | hr | 6 | 6 | |
| Type | | Veg. | Veg. | |
| Bottom Width | ft | 400 | 240 | |
| Velocity of Flow (Ve) | ft/sec | 6.0 | 5.9 | |
| Slope of Exit Channel | ft/sec | 0.03 | 0.024 | |
| Maximum Reservoir Water Surface Elevation | ft | 841.4 | 830.7 | |
| Freeboard Design | | | | |
| Rainfall Volume (FH) (Areal) (6-hr) | in | 23.75 | 23.75 | |
| Runoff Volume (FH) | in | 20.67 | 20.67 | |
| Storm Duration | hr | 6 | 6 | |
| Maximum Reservoir Water Surface Elev. | ft | 844.7 | 834.3 | |
| Capacity Equivalents | | | | |
| Sediment Volume | in | 0.63 | 0.48 | |
| Retarding Volume | in | 3.10 | 2.60 | |

1/ Crest of emergency spillway
2 Sediment capacity will not store water.

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TABLE 3A - STRUCTURAL DATA

CHANNELS

BRILLION WATERSHED, WISCONSIN

| (Name) | Station | Drainage Area (sq. mi.) | Capacity cfs Req'd. | Capacity cfs Design | Hydraulic Gradient (ft./ft.) | Channel Dimensions Bottom Width (ft.) | Bottom Grade (%) | Depth of Flow (ft.) | Side Slopes | "n" Value Aged | "n" Value As-Built | Velocities ft./sec. Aged | Velocities ft./sec. As-Built | Excavation (cu. yd.) | Type 1/ of Work | Before Project Type of 2/ Channel | Before Project Flow 3/ Condition |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Long Lake Outlet Channel Modification | 12+00 38+00 | 1.64 | 193 | 193 | 0.00013 | 50 | 0.115 | 2.6 | 3:1 | 0.04 | 0.025 | 1.28 | 1.29 | 22,300 | II | M (1945) | Pr |

1/ II - Enlargement or realignment of existing channel or stream.

2/ M ( ) - Manmade ditch or previously modified channel and approximate date of original major construction.

3/ Pr - Perennial - flows at all times except during extreme drought.

January 1975

TABLE 3B - STRUCTURAL DATA

OUTLET STRUCTURE

BRILLION WATERSHED, WISCONSIN

| Site | Drainage Area (sq mi) | Design Cap. Prin. Spill (cfs) | Assoc. Frequency and Duration of Storm (% change and hours) | Drop (ft) | Concrete (cu yd) | Type of Structure |
|---|---|---|---|---|---|---|
| Long Lake Outlet | 1.64 | 193 | 1, 24 | 3 | 60 | Type C Reinforced Concrete Drop Spillway |

January 1975

TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS
BRILLION WATERSHED. WISCONSIN
(Dollars) 1/

| Item | Estimated Average Annual Damage | | Damage Reduction Benefit |
|---|---|---|---|
| | Without Project | With Project | |
| Floodwater | | | |
| Crop and Pasture | 1,260 | 600 | 660 |
| Roads and Bridges | 1,720 | 200 | 1,520 |
| Nonagricultural | | | |
| Urban | 41,140 | 160 | 40,980 |
| Subtotal | 44,120 | 960 | 43,160 |
| Sediment | | | |
| | 550 | 320 | 230 |
| Subtotal | 550 | 320 | 230 |
| Indirect | 4,580 | 120 | 4,460 |
| Total | 49,250 | 1,400 | 47,850 |

1/ Adjusted normalized prices for agricultural damages and current prices for nonagricultural damages.

January 1975

TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

BRILLION WATERSHED, WISCONSIN

(Dollars)

| Evaluation Unit | AVERAGE ANNUAL BENEFITS 1/ | | | Average Annual Cost 3/ | Benefit-Cost Ratio |
|---|---|---|---|---|---|
| | Damage Reduction | Secondary | Total | | |
| Floodwater Retarding Structures 1 and 2 | 41,350 | 3,740 | 45,090 | 13,640 | 3.3:1.0 |
| Long Lake Outlet Structure | 6,440 | 590 | 7,030 | 4,000 | 1.8:1.0 |
| Project Administration | | | | 2,215 | |
| GRAND TOTAL | 47,790 2/ | 4,330 | 52,120 | 19,855 | 2.6:1.0 |

1/ Adjusted normalized prices for agricultural damages and current prices for nonagricultural damages.

2/ In addition, it is estimated that land treatment will provide flood damage reduction benefits of $60 annually.

3/ From table 4.

January 1975

## INVESTIGATION AND ANALYSES

The following section presents information that is pertinent in supporting the conclusions of this plan. Sufficient information is included to explain the technical aspects of the plan. Generally, information such as how surveys were made, kind of maps used, technical procedures, and criteria used, are not included in this section. Such items of a routine nature are set forth in the Soil Conservation Service handbooks of Watershed Protection, Hydrology, Hydraulics, Geology, and Economics, and in Soil Conservation Service memoranda.

## LAND USE AND TREATMENT

Land treatment measures to be applied on cropland and pasture areas during the project period were based on the application of procedures given in Advisory Notice W-748.

Forest land problems and treatment needs were determined from watershed investigations and from recommendations of the Wisconsin Department of Natural Resources and the U.S. Forest Service.

Cost of technical assistance for installation of the land treatment measures was based on the average work performance time for each of the individual measures to be applied. The cost of additional technical assistance to be borne by Public Law 566 funds was determined by subtracting the cost of technical assistance available within the watershed under the ongoing program from the total estimated cost of technical assistance.

The unit costs of establishing the land treatment measures were obtained by checking cost records in the area under the going program of the Calumet and Manitowoc Counties Soil and Water Conservation Districts, the Wisconsin Department of Natural Resources, and the Agricultural Stabilization and Conservation Service program of cost sharing. These unit costs were used in computing the cost of the accelerated land treatment program.

The individual landowners will bear the cost of application. Basic data, computations, and cropland and grassland acres to be treated are on file in the Soil Conservation Service Office, Madison, Wisconsin.

Basic data for forest land are on file in the Northeastern Area - State and Private Forestry Field Office of the Forest Service, St. Paul, Minnesota.

## HYDROLOGIC INVESTIGATIONS

Hydrologic investigations were made to determine the peak flow and runoff volume characteristics, structural design hydrographs, and peak flow-frequency relationships for economic analyses.

### Basic Data

No stream gaging stations are located within the watershed. Precipitation records have been kept continuously at the Weather Bureau substation in Brillion since 1924. The precipitation records are published monthly in Climatological Data (5).

The watershed was evaluated using a partial duration, 24-hour, synthetic storm series. Point rainfall quantities for selected frequencies were obtained from Weather Bureau Technical Paper No. 40 (6). The monthly distribution of storms was based upon data compiled for previous watershed studies in the area.

Soil and cover reconnaissance surveys were made of the watershed and curve numbers were assigned, using procedures described in Chapters 7, 8, and 9 of Part 1, Section 4, National Engineering Handbook (NEH).

Synthetic hydrographs were developed for 16 subareas, combined at various locations and routed through the watershed using the computer and computer program described in Technical Release 20. Hydrographs were developed and routings made for present conditions and with various structural combinations.

Peak discharge values produced by three rainfall events for present conditions, and with structures in place were obtained. Discharge versus runoff curves were drawn, with the values established, and used to obtain discharge values for runoff at other frequencies.

The frequencies of storms that occurred in the Brillion watershed in 1924, 1942, 1966, and 1969 were estimated by comparing rainfall amounts with point rainfall quantities from the Weather Bureau Technical Paper No. 40 (6).

Times of concentration were derived from stream channel hydraulics. Cross-sections of the stream channel were obtained by field survey at 30 locations. Bridge openings and road profiles were surveyed at 22 locations. Additional cross-sections were taken from detailed topographic maps. All surveys were referenced to mean sea level datum. Procedures outlined in Chapter 15, Part 1, Section 4, NEH, were used.

## Structure Design

Floodwater detention storage for the floodwater retarding dams was based on the estimated runoff from a 100-year frequency storm. Principles outlined in Section 4, NEH, were followed.

Flood routings for the floodwater retarding structures were accomplished using methods described in Chapter 17, Part 1, Section 4, NEH.

Emergency spillway and freeboard hydrographs were computed using criteria established in Engineering Memorandum SCS-27 (Revised March 19, 1965) and the techniques described in Chapter 21, Part 1, Section 4, NEH.

## Damage Frequency Analyses

Surveyed sections and existing maps were used to represent the flood plain characteristics at 98 locations in the watershed where stage-discharge curves were developed. Stage-discharge curves and stage-area inundated curves were determined using the computer program described in Computer Program for Project Formulation - Hydraulics.

The runoff volumes were reservoir routed through the structures to establish the amount of runoff stored by the structures during the passage of selected events.

A map showing flood damage areas in the watershed (figure 5) was developed. Detailed information previously described was extended using nondetailed procedures to areas in the watershed not subject to flood control from the proposed structures.

## GEOLOGIC INVESTIGATIONS

A geologic reconnaissance survey of Brillion watershed was made to determine lithology, stratigraphic sequence, and general structure of the bedrock in the watershed.

Two high hazard (class c) floodwater retarding structures (FRS), two channel reaches, and one drop spillway structure were investigated. Investigations were made using guidelines established in the National Engineering Handbook, Section 8 - Engineering Geology, and Technical Release 25 - Planning and Design of Open Channels.

A preliminary subsurface foundation investigation was made at both FRS sites using a backhoe. Eight backhoe test pits were made at each site. Maximum depth of investigation was 12 feet. A geologic report was prepared for each site. The FRS foundations and borrow areas are mainly in a clayey glacial till (CL). Twenty-one earth samples were submitted for testing to SCS Soils Mechanics Laboratory in Lincoln, Nebraska. Laboratory analyses, and design recommendations were returned. The geologic and soil mechanics reports indicate that the sites are feasible for the proposed structures. The two channel reaches and drop spillway structure were investigated using a backhoe, soil probes, and augers. The channel reach west of Brillion has been dropped. The channel reach and associated drop spillway structure for Long Lake outlet was field investigated by means of a soil probe. Five holes were made to a maximum depth of 9.5 feet for the preliminary investigation. A preliminary geologic report was prepared. The earth materials in this channel reach are about half organics (OL, OH, and peat) and half clayey till (CL). The drop spillway is located on clayey till (CL). Three samples were submitted to the Soils Mechanics Laboratory in Lincoln for testing. The test results have been received. The preliminary geologic report and the laboratory test results indicate the sites are feasible based on preliminary design criteria.

A complete foundation and borrow investigation program will be made for all structure sites during the design stage.

## EROSION AND SEDIMENTATION INVESTIGATIONS

Investigations of erosion and sedimentation were made in accordance with procedures outlined in current watershed memoranda, National

Engineering Handbook, and Technical Release No. 12, Procedure - Sediment Storage Requirements for Reservoirs, January, 1968.

Geologic maps, topographic maps, soil survey maps, aerial photographs, and field reconnaissance were used in evaluating erosion and sedimentation.

Steambank erosion occurs as an occasional raw bank with an average height of about 4 feet. Channel erosion above and below the structure sites is variable but is generally less than 0.075 feet per year. Sediment resulting from streambank, streambed, and gully erosion was estimated to be five percent of the gross sheet erosion delivered to the structure sites.

Roadside erosion combined with erosion from farmsteads and buildings was estimated to be ten percent of the gross sheet erosion of the watershed.

Upland sheet erosion computations were determined by the Universal Soil Loss Equation. Data for capability classes, land use practices, and rotations were furnished by the district conservationist of Calumet County. Predicted sediment storage requirements for a 100-year period for structure site 1 is 0.63 watershed inches and 0.48 watershed inches for structure site 2.

Densities of inorganic soils of the watershed vary from 97 to 116 pounds per cubic foot. Within the reservoirs the submerged sediment will have an average density of 80 pounds per cubic foot and the aerated sediment will have an average density of 100 pounds per cubic foot. An estimated four percent of the fine sediments (mostly silt and clay) will pass through the structures.

## ECONOMIC INVESTIGATIONS

### General

The location and extent of historic floodwater damages were determined from economic field surveys and interviews with residents. Basic information such as land use, crop yields, and cropping practices were obtained from interviews with farmers in the watershed

and local soil conservation technicians. Town officials and local residents provided information concerning floodwater damages to roads and bridges.

Adjusted normalized prices were used in computing agricultural floodwater damages and benefits and project operation and maintenance costs. Current prices were used to determine urban and road and bridge damages and benefits. These price standards are for use in estimating deferred project effects and are outlined in the publication, Interim Price Standards For Planning and Evaluating Water and Land Resources, issued in April 1966 by the Interdepartmental Staff Committee of the Water Resources Council, Washington, D.C. Current (1973) prices were used to estimate the cost of all structural and land treatment measures.

Installation costs for structural works of improvement were amortized at five and five-eights percent interest for a 100-year evaluation period to determine average annual costs.

## Floodwater Damages

Estimates of floodwater damages to crops and pasture were based on land use and average flood-free yields in the watershed. Present flood-free crop yields were adjusted upward to reflect increases in yields that can be expected from advanced agricultural technology.

Floodwater damage to cropland and pasture was evaluated on the basis of floodwater damage factors developed for the State of Wisconsin. Damage rates for each crop (corn, oats, hay, and pasture) were determined for the 0-1 feet, 1-3 feet, and over 3-foot categories by months. These monthly values were weighted by the percent o annual floods which occur during each month of the growing season and totaled to determine an average annual damage rate.

Annual damage rates for corn, oats, and hay were then converted to a composite flood plain crop acre. The damage rate per composite crop acre and pasture acre in each depth category was applied to the acres inundated as computed by the hydrologist for the 100, 50, 25, 10, 5, and 2-year frequency floods. These damages were converted to average annual by developing damage-frequency of occurrence curves for the following conditions:

1. Without project

2. With land treatment measures installed

3. With land treatment and structural works of improvement installed

Estimated floodwater damages to public roads and bridges were based on information from interviews and by field observations. Historic and anticipated damages by elevation and storm frequency were determined for each road and bridge location subject to floodwater damage. Average annual floodwater damages were developed by relating the estimated repair and maintenance costs from floodwater damage to stage, and stage to percent frequency of occurrence. Damages caused by the various frequency storms were plotted graphically with the area beneath the curve representing the average annual damage.

Field surveys and interviews with local residents were made to determine the type, extent, and location of historic floodwater damages in Brillion and the urban development on the shores of Long Lake. City officials provided information about floodwater damages to public facilities in Brillion. Local residents were interviewed to obtain information about urban floodwater damages to private residences and businesses. Anticipated damages were determined for each building subject to floodwater damage.

It was determined from hydrologic data that floods for 1969 approximated the 5-year flood. Average annual urban floodwater damages were developed by relating the estimated repair, replacement, and maintenance costs to stage, and stage to percent chance of occurrence. From this data a stage-damage curve was developed and related to frequency to obtain average annual damage without project. The change in stage for given frequencies with project provided the benefits which are expected to result from works of improvement.

Sediment yields were determined from upland sheet erosion, flood plain scour, and streambank erosion surveys. Quantifying sediment reduction benefits involved establishing a monetary value per unit of sediment reduction to a major stream or a point downstream beyond which sediment reduction benefits cannot be readily identified. The cost of sediment storage was calculated by the use of facilities method of cost allocation. These values are based on the unit costs of sediment storage and it is assumed that benefits derived from sediment reduction is at least equal to the costs.

## Indirect Damages

Indirect damages otherwise unaccounted for in the evaluation of floodwater damages were estimated as a percentage of direct floodwater damages. Ten percent was used for agricultural losses such as the inability of farmers to readily transport crops and produce to market because of flooding. Indirect damages resulting from direct damages to public roads, bridges, and culverts were estimated at 20 percent. Examples of indirect damage to these facilities are expenses of extra travel around flooded areas, costs incurred by local and State agencies for actual traffic rerouting, and high road maintenance costs from the use of detour routes not built to withstand heavy traffic. Indirect urban damages such as loss of income to commercial establishments, traffic rerouting, interruption of utility service, etc., were estimated at 15 percent of direct urban damage.

## Project Benefits

Floodwater damage reduction benefits were computed as the difference between damages without project and those remaining with project.

## Secondary Benefits

Local secondary benefits were computed in accordance with Chapter 11 of the Economics Guide for Watershed Protection and Flood Prevention (Revised 1964). Local secondary benefits stemming from the project were estimated at ten percent of the total direct project benefits.

Secondary benefits from a local viewpoint have been evaluated and included in the economic justification of the project. Although secondary benefits will accrue from a national standpoint, they have neither been evaluated nor included in the benefit-cost ratio.

## ENGINEERING INVESTIGATIONS

### Maps and Surveys

The structure site and reservoir area topographic data for design and quantities were obtained from field surveys and the 2-foot contour maps prepared by the Board of Soil and Water Conservation Districts.

Photogrammetric topographic maps with a scale of 1 inch equals 200 feet with 2-foot contours, prepared by the Wisconsin Board of Soil and Water Conservation Districts, were utilized as base maps for the floodwater retarding structure designs. Centerline profiles of the floodwater retarding structures (FRS) and Long Lake outlet were surveyed and used as a basis for determining volumes of excavation and embankment.

### Design Criteria

Both floodwater retarding structures were designed to contain a 100-year accumulation of sediment. The principal spillway riser is designed with the low stage floodwater release at the 100-year sediment pool elevation. A slide gate will allow the pool to be operated dry or at the 100-year sediment elevation.

The principal spillways are designed to release the flood detention volumes in less than 10 days.

Hazard class "c" design criteria were used for both floodwater retarding structures. Floodwater volume from a 100-year storm event will be stored in the detention pool and slowly released through the principal spillway.

The earth embankment design was based on a study of foundation and fill material. The nature and characteristics of these materials were determined by preliminary subsurface investigations and laboratory test results of soil samples.

The Long Lake outlet is a type C drop spillway structure. It will pass the 100-year flood event with a maximum rise in the lake level of 1-foot. This will provide the desired protection to the lake shore properties without lowering the normal lake level. The crest elevation of the structure will be established by the Wisconsin Department of Natural Resources at a permit hearing. In order for the outlet structure to function properly 0.5 mile of channel work is required.

Structural designs were based on procedures and criteria set forth in Engineering Memorandum SCS-27, Section 4, National Engineering Handbook, Washington Technical Releases 2 and 25; Wisconsin Engineering Memorandum WI-6; and applicable Wisconsin Engineering Standards.

## Alternate Studies

Six potential floodwater retarding structure sites were evaluated. Four sites were rejected because of insufficient benefits. Several multiple-purpose channels were also evaluated. The channels were rejected because of high land right costs.

## Cost Estimates

Unit costs used in the engineer's estimate were based primarily on costs of previous Public Law 566 contracts for flood prevention projects in Wisconsin. The state conservation engineer maintains an annual cost summary based on recent unit bid prices. These average unit prices are adjusted to reflect differences in site conditions which make construction easier or more difficult than in an average situation.

The cost estimate for road modification was based on unit prices provided by the Highway Department.

Present land values were used as a basis for computing land rights costs. The local sponsors provided estimated land acquisition costs on a site-by-site basis.

Cost of operation and maintenance of the structural measures was based on experience from similar structures, and adjusted to meet local conditions.

## FISH AND WILDLIFE INVESTIGATIONS

In June 1969, fish and wildlife investigations were conducted by the Bureau of Sport Fisheries and Wildlife of the United States Department of the Interior in cooperation with the Wisconsin Department of Natural Resources and the Soil Conservation Service.

Copies of the complete fish and wildlife report, July 27, 1970, may be obtained from the Bureau of Sport Fisheries and Wildlife office at Minneapolis, Minnesota.

In keeping with Soil Conservation Service policies concerning the conservation and development of fish and wildlife resources, the state conservationist of the Soil Conservation Service established an interagency biological team to evaluate the impact of Public Law 566 projects on forestry, fish, wildlife, and other natural resources in June 1971.

A comprehensive biology investigation of the impact of proposed structural measures on fish, wildlife, and forestry resources for the Brillion watershed was conducted in August 1971. Each proposed site was reviewed and benefited areas examined in the field. Evaluations were made, using forms developed locally and by the Lincoln Regional Technical Service Center.

Fish and wildlife habitat was inventoried for dams and spillways, sediment pools, flood pools, benefited areas, wetlands, and streams. Terrestrial habitats were classified as woods, grass, and crops. Aquatic habitats consisting of streams, wetlands, and fishing lakes were considered separately.

Existing habitat acreages at each site were weighted with a quality index relative to importance for fish and wildlife. Anticipated changes in habitat as a result of the watershed project were computed in a similar fashion. Final gain and loss figures are expressed in acres having the highest habitat values. The structure site, plus the benefited area, was considered as a unit.

Copies of the complete biology investigation report may be obtained from the Soil Conservation Service, Madison, Wisconsin.

## ARCHEOLOGICAL AND HISTORICAL INVESTIGATIONS

An archeological survey of the Brillion watershed was conducted by the State Historical Society of Wisconsin in May 1974. Floodwater retarding structure sites No. 1 and No. 2 and the Long Lake outlet structure and associated channel were thoroughly investigated.

Intensive surface collecting was done in all cultivated areas. In areas that looked particularly promising as sites of prehistoric activities, where surface collecting was either hampered or made impossible by dense growth of vegetation, test pits, usually 3 feet square, were excavated into the first sterile soil level. Test pits were also excavated in areas that produced surface collections. A total of 41 test pits were excavated.

The small quantity of archeological material from the areas of floodwater retarding structures No. 1 and No. 2 indicates limited use of the area by prehistoric peoples. Since recovered material is sparse and confined to the surface or plow zone, further excavation in the area is not warranted. No evidence of prehistoric activity was found in the Long Lake area. It can be concluded that the construction of the Brillion watershed will not affect significant archeological information.

Copies of the archeological report dated May 31, 1974, may be obtained from the Soil Conservation Service, Madison, Wisconsin, or the State Historical Society of Wisconsin, Madison, Wisconsin. All materials recovered in the survey and field notes are on file in the Anthropology Section, Museum, State Historical Society of Wisconsin, Madison, Wisconsin.

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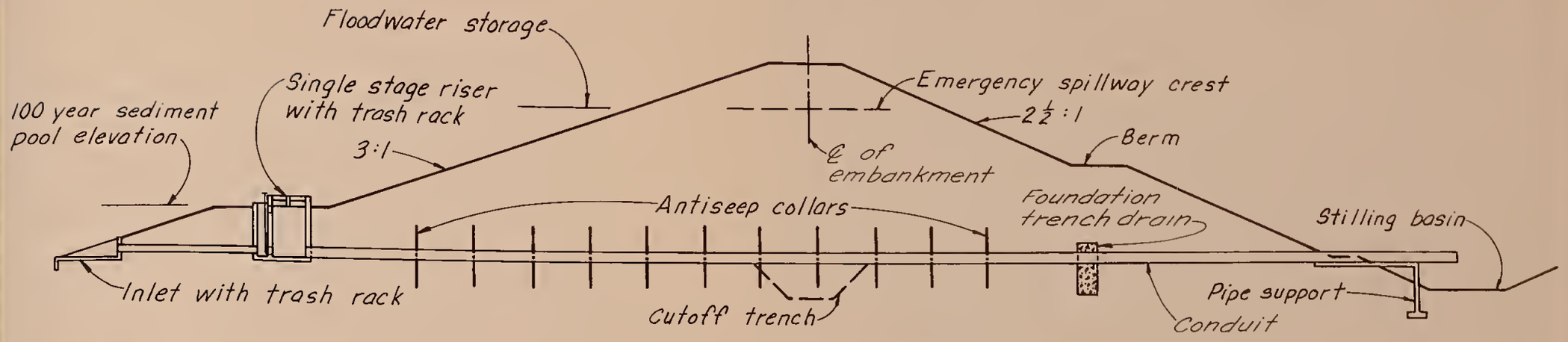
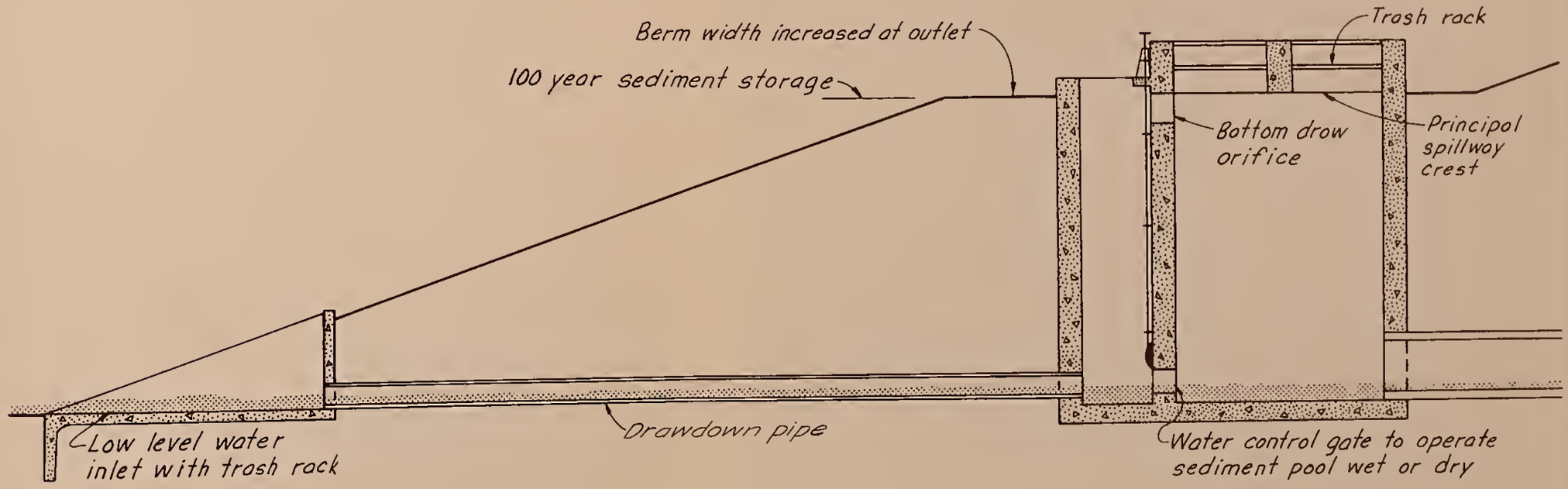
National Engineering Handbook, Section 3, Sedimentation
National Engineering Handbook, Section 4, Hydrology
National Engineering Handbook, Section 5, Hydraulics
National Engineering Handbook, Section 6, Structural Design
National Engineering Handbook, Section 8, Engineering Geology
Washington Engineering Memorandum, 1-78
Washington Watershed Memorandum, 1-125
Washington Environmental Memorandum, 1-14
Washington Technical Releases, 1-40
Watershed Protection Handbook

# FIGURE 1 - TYPICAL FLOODWATER RETARDING STRUCTURE



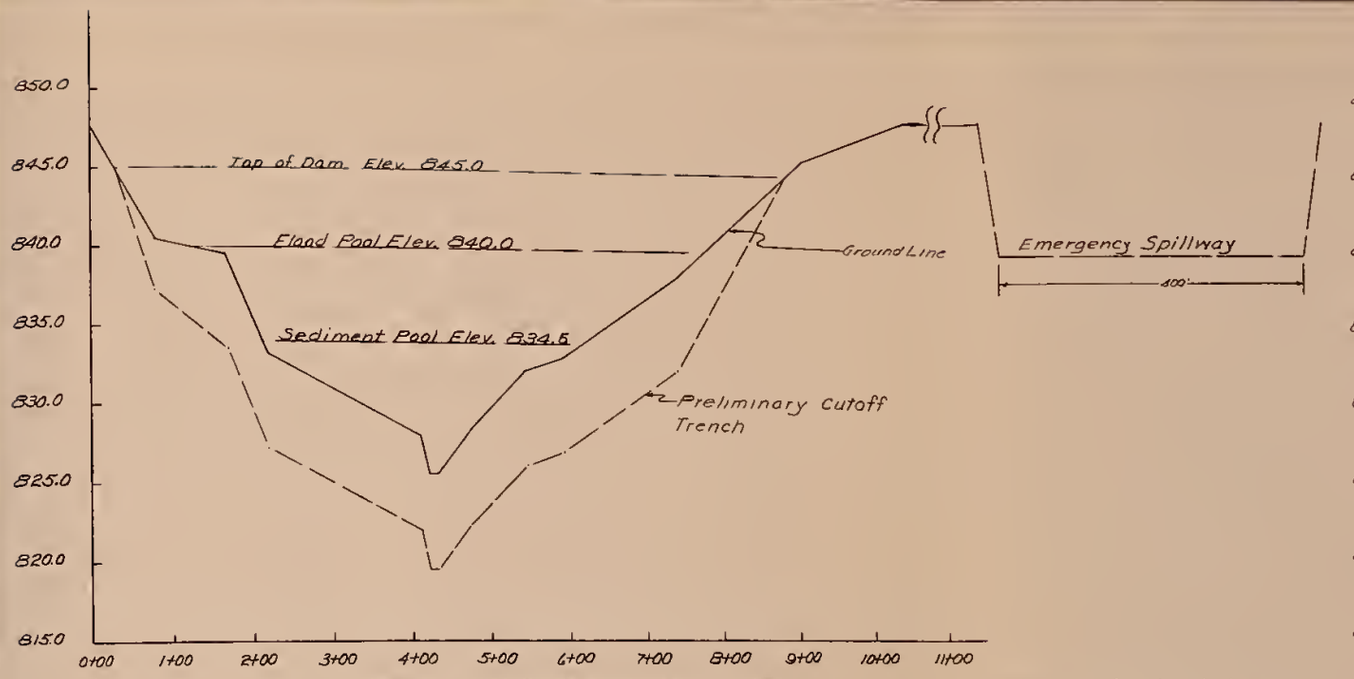

CROSS SECTION ON CENTERLINE



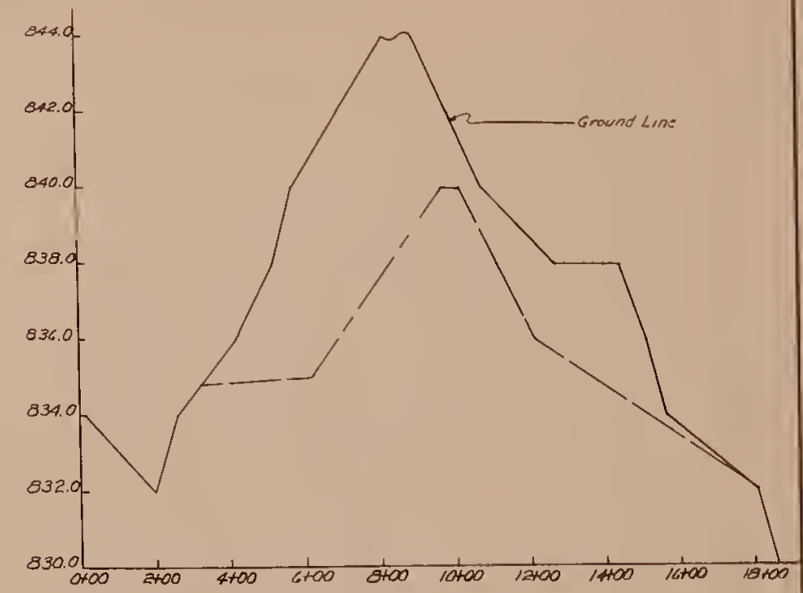

INLET WORKS SHOWING WET OR DRY SEDIMENT POOL OPERATION

2-26-73
5,N-31,422

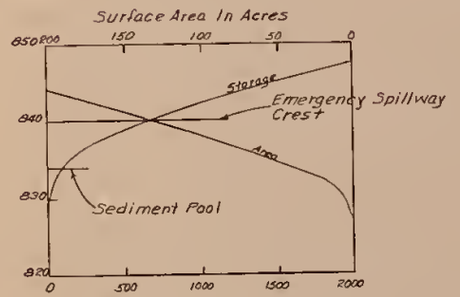
USDA-SCS-LINCOLN, NEBR. 1972



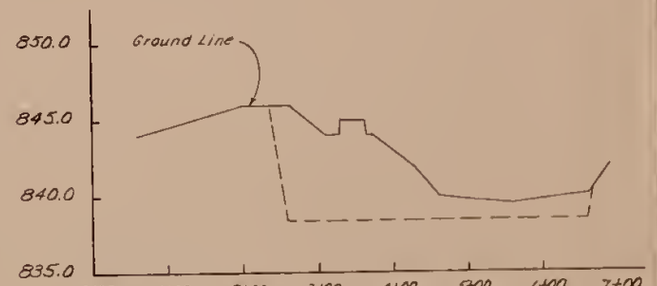

FLOODWATER RETARDING STRUCTURE & PROFILE



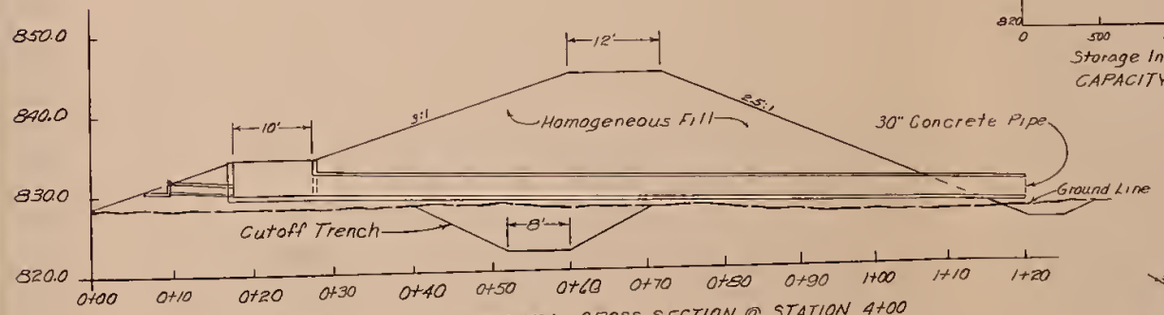

EMERGENCY SPILLWAY & PROFILE



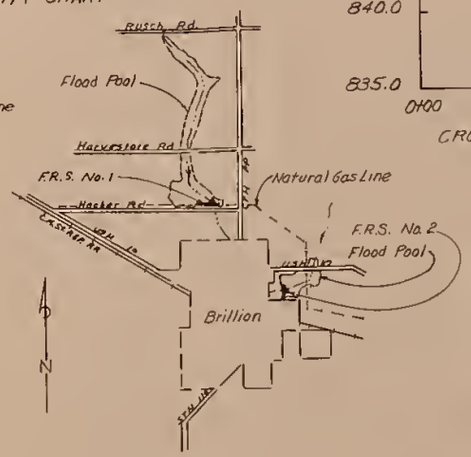

CAPACITY CHART




CROSS SECTION EMERGENCY SPILLWAY @ STATION 9+00




FLOODWATER RETARDING STRUCTURE NO.1, CROSS SECTION @ STATION 4+00



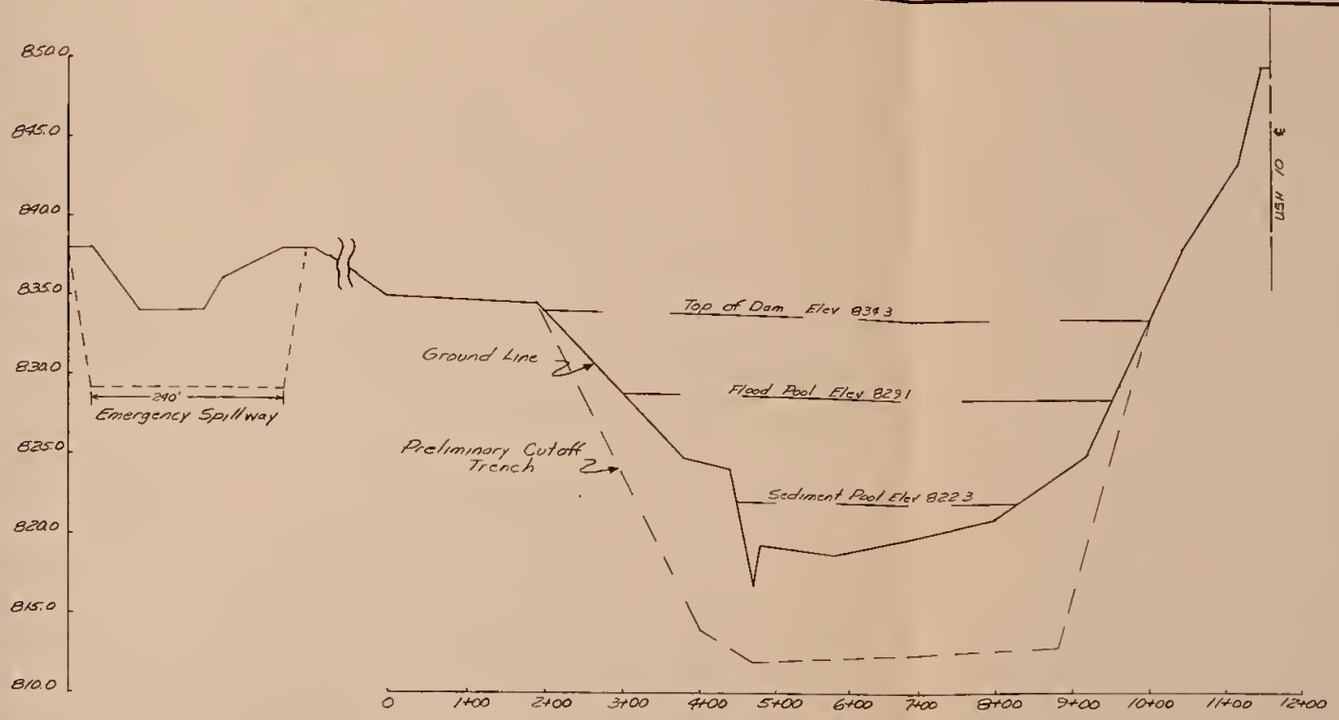

Location Map

Note: Preliminary Plans Subject to Revision in Final Design

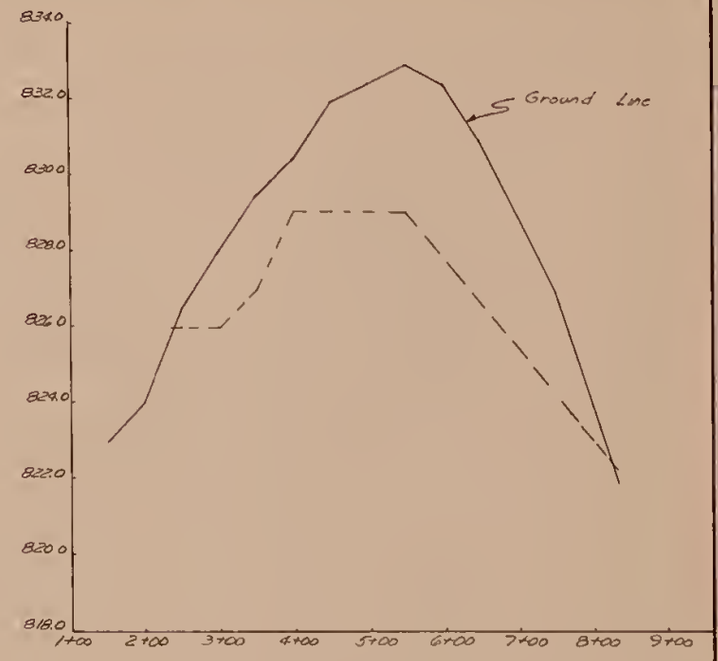
BRILLION WATERSHED
CALUMET & MANITOWOC CO., WIS.
FLOODWATER RETARDING STRUCTURE NO. 1
FIGURE 2

**U. S. DEPARTMENT OF AGRICULTURE**
**SOIL CONSERVATION SERVICE**

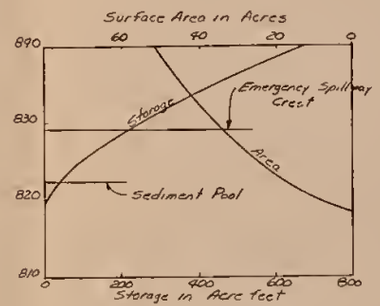
| | | | |
|---|---|---|---|
| Designed E. Kubler, P.E. | Date 7/73 | Approved M. Trewyn, P.E. | |
| Drawn E. Brinkhoff | 8-73 | Title State Conservation Engineer | |
| Traced | | Title | |
| Checked P. Cavanaugh | | Sheet No. 1 of 2 | Drawing No. 5-E-32,600 |



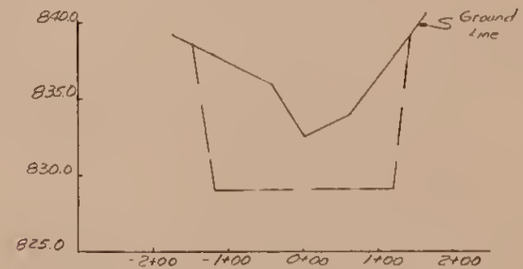

FLOODWATER RETARDING STRUCTURE NO. 2 & PROFILE



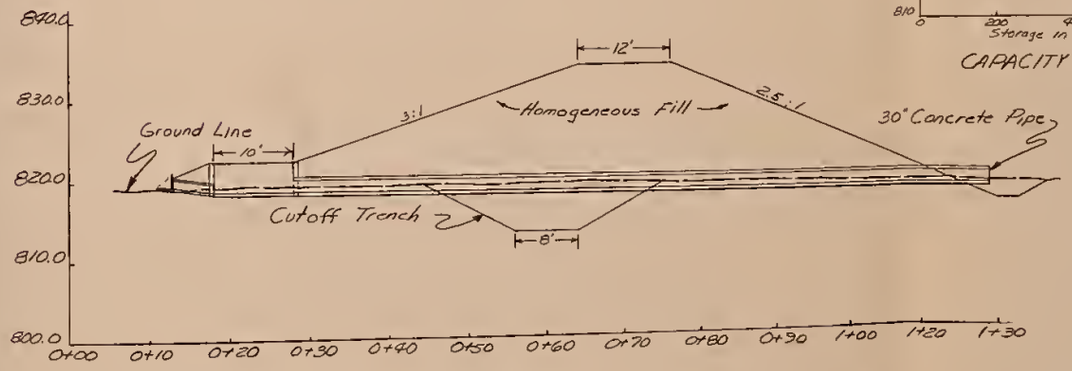

EMERGENCY SPILLWAY & PROFILE



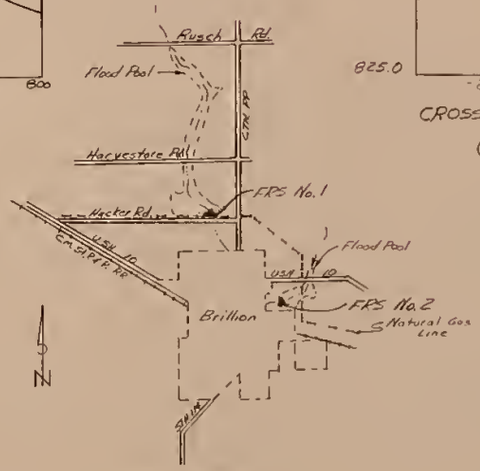

CAPACITY CHART




CROSS-SECTION EMERGENCY SPILLWAY @ STATION 5+00




FLOODWATER RETARDING STRUCTURE NO. 2 CROSS-SECTION @ STATION 5+00




LOCATION MAP

Note: Preliminary Plans Subject to Revision in Final Design

BRILLION WATERSHED
CALUMET & MANITOWOC CO., WIS.
FLOODWATER RETARDING STRUCTURE NO. 2
FIGURE 3

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

| | | | |
|---|---|---|---|
| Designed E. Kubler, P.E. | Date 7-73 | Approved by M. Knabach, P.E. | |
| Drawn M. Waugh | 8-73 | Title State Conservation Engineer | |
| Traced | | Date | |
| Checked J. P. Cavanaugh | | Sheet No. 2 of 2 | Drawing No. 5.E-32,600 |

U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE


Figure 4

# CITY OF BRILLION

## FLOOD DAMAGE AREAS
## CALUMET COUNTY , WISCONSIN

LEGEND

- 100-YEAR FLOOD WITHOUT PROJECT
- 100-YEAR FLOOD WITH PROJECT
- CITY LIMITS

N

NOTE:
LANDFILL IN THE FLOOD PLAIN AND REPLACEMENT OF BRIDGES AND CULVERTS WILL CHANGE BOUNDARY OF FLOOD AREA.

1000 0 1000 2000

SCALE IN FEET
APPROXIMATE

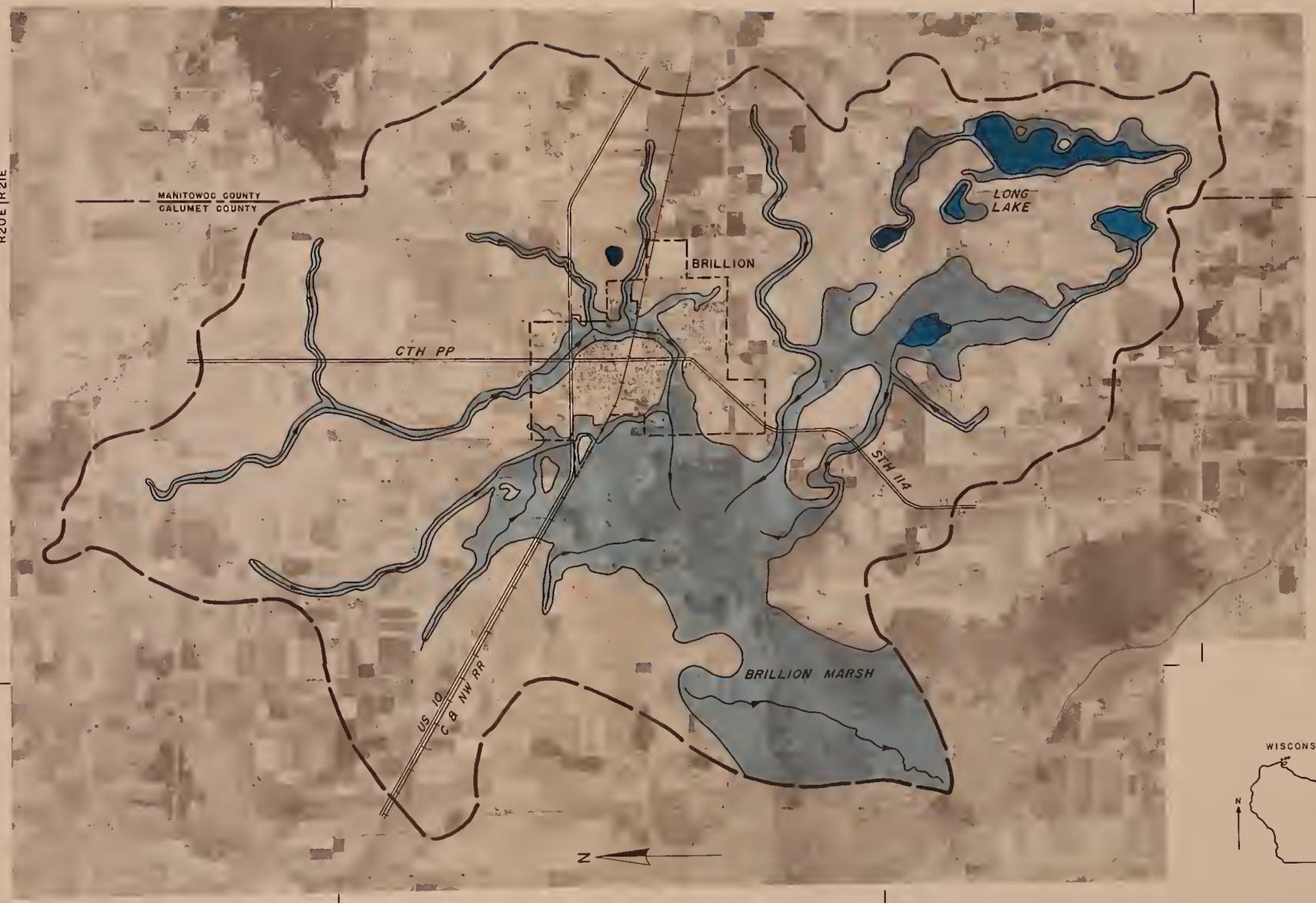
SOURCE
AERIAL PHOTO SERIES BHN-IMM(1971)
AND INFORMATION FROM FIELD

REV. 4-18-74
10-9-73
5,0-32,600.2

USDA-SCS-LINCOLN NEBR. 1974

U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE




# Figure 5
# BRILLION WATERSHED

## FLOOD DAMAGE AREAS
## CALUMET AND MANITOWOC COUNTIES, WISCONSIN

### LEGEND

- WATERSHED BOUNDARY
- CITY LIMITS
- STREAMS
- LAKES
- 100-YEAR FLOOD WITHOUT PROJECT




SCALE 1 0 1/2 1 MILES

APPROXIMATE

SOURCE :
AERIAL PHOTOS SERIES BHN-1MM (1971)
AND INFORMATION FROM FIELD

REV. 3-25-74
5,0-32,600.3

USDA-SCS-LINCOLN, NEBR. 1974

U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

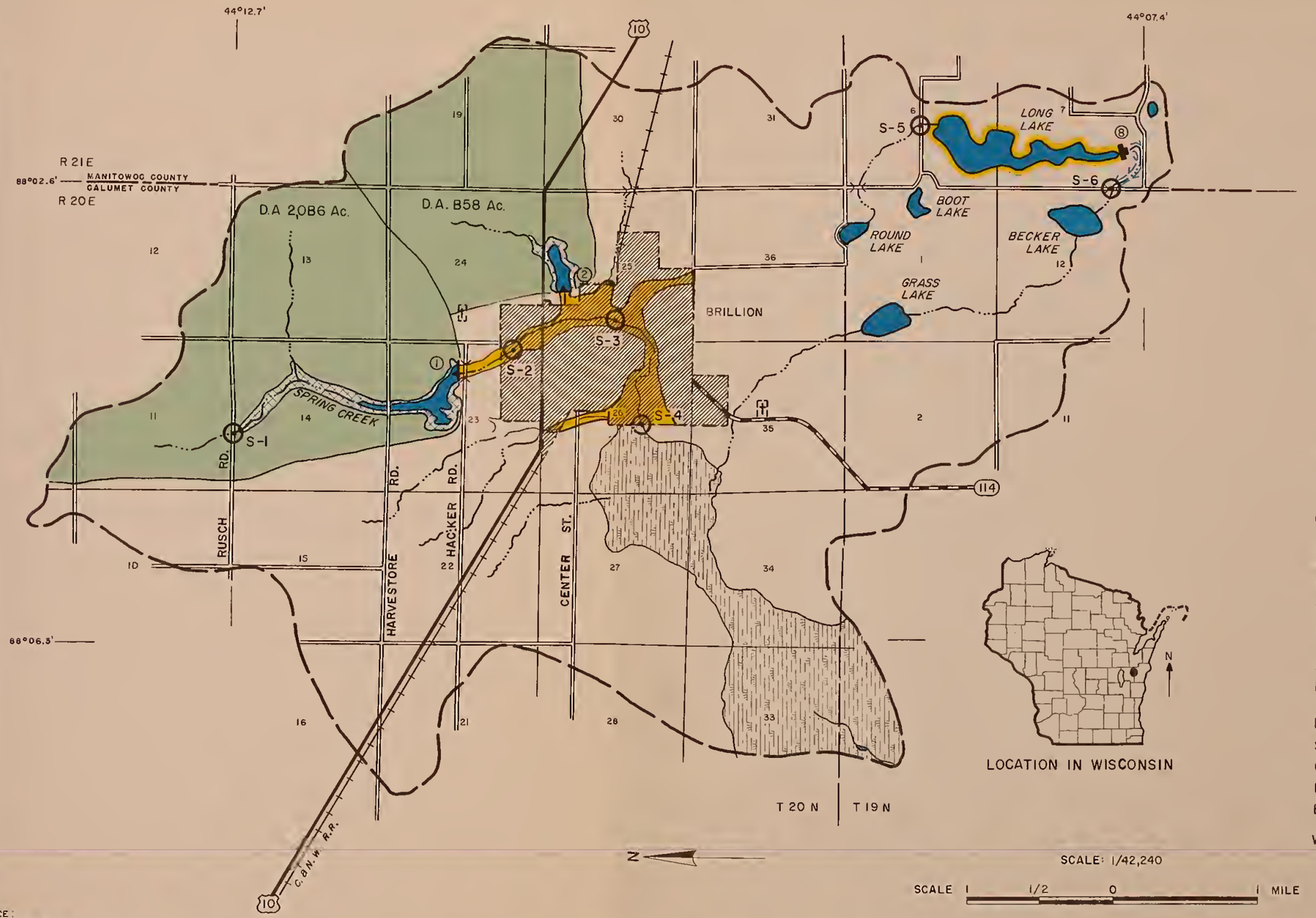



Figure 6

PROJECT MAP

# BRILLION WATERSHED

CALUMET AND MANITOWOC COUNTIES
WISCONSIN

LEGEND

- COUNTY LINE
- CIVIL TOWNSHIP LINE
- SECTION LINE
- SECTION NUMBER 13
- U. S. HIGHWAY
- STATE TRUNK HIGHWAY
- COUNTY TRUNK AND TOWN HIGHWAY
- RAILROAD
- BRIDGE, ROAD
- CEMETERY
- CITY
- PERENNIAL STREAM
- INTERMITTENT STREAM
- PERENNIAL LAKE OR POND
- WATERSHED BOUNDARY
- DRAINAGE AREA CONTROLLED BY STRUCTURE D. A. 12 Ac.
- AREA BENEFITED
- FLOODWATER RETARDING STRUCTURE
- LAKE OUTLET STRUCTURE
- STRUCTURE NUMBER ①
- CHANNEL WORK
- DRAINAGE AREA ACREAGE D. A. 12 Ac.
- BRILLION MARSH
- WATER QUALITY SAMPLE STATION ⊙ S-1

SOURCE:
INFORMATION FROM FIELD

REV. 3-21-74
5,0-32,600.4

USDA-SCS-LINCOLN, NEBR. 1974